Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Expanding Flexible Use of the 3.7 to 4.2 GHz Band	)	GN Docket No. 18-122
	)	
Petition for Rulemaking to Amend and Modernize Parts 25 and 101 of the Commission's Rules to Authorize and Facilitate the Deployment of Licensed Point-to-Multipoint Fixed Wireless Broadband Service in the 3.7-4.2 GHz Band	)	RM-11791
	)	
Fixed Wireless Communications Coalition, Inc., Request for Modified Coordination Procedures in Band Shared Between the Fixed Service and the Fixed Satellite Service	)	RM-11778

COMMENTS OF T-MOBILE USA, INC.

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T-Mobile USA, Inc. ("T-Mobile")[1/] submits these comments in response to the Notice of Proposed Rulemaking ("*NPRM*")[2/] in the above-referenced proceeding. T-Mobile applauds the Commission's efforts to promote United States leadership in Fifth Generation ("5G") wireless deployment, by proposing to permit use of the 3.7-4.2 GHz band for terrestrial services. To accomplish that most efficiently and provide a market-based mechanism to maximize the amount of spectrum for terrestrial use, while still ensuring that valuable programming and other services can be delivered, the Commission should adopt T-Mobile's market approach. Wireless companies today measure broadband spectrum in gigahertz, not megahertz, and wireless spectrum auctions have contributed more than $100 billion in auction revenue to the United

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1/ T-Mobile USA, Inc. is a wholly-owned subsidiary of T-Mobile US, Inc., a publicly traded company.

2/ *Expanding Flexible Use of the 3.7 to 4.2 GHz Band, et al.*, Order and Notice of Proposed Rulemaking, FCC 18-91 (rel. July 13, 2018).

States Treasury. The satellite operators' proposal, by contrast, caps spectrum for broadband at 180 megahertz and directs all spectrum revenue to satellite investors and none to taxpayers. Auctioning the 3.7 GHz band will generate more broadband spectrum – and more public interest benefits for consumers and taxpayers – than the satellite operators' proposal.

I. INTRODUCTION AND SUMMARY

T-Mobile proposes a Commission-administered, market-based auction mechanism to maximize the use of the 3.7-4.2 GHz band by terrestrial licensees, while permitting satellite operators to retain sufficient spectrum to continue to provide services to their customers and share in the revenue generated from that auction. T-Mobile's market-based auction would feature multiple phases in which all satellite licensees would be the seller and potential wireless providers would be the buyers. With each succeeding phase of the auction, decreasing amounts of spectrum would be made available until the Commission reached a minimum amount of spectrum available for terrestrial networks. T-Mobile recommends that the Commission set that floor at 300 megahertz in most areas (*i.e.*, satellite operators would be able to retain 200 megahertz). In certain locations defined by satellite operators, outside of major metropolitan areas, satellite operators would only be required to make 200 megahertz available, and could retain 300 megahertz for satellite operations.

T-Mobile's market-based approach will best promote the public interest. Unlike the plan offered by satellite operators, T-Mobile's proposal would:

- Provide a sufficient amount of mid-band spectrum to meet the need for mobile wireless broadband. In contrast, the C-Band Alliance has only committed to making 180

megahertz of the 3.7-4.2 GHz band available for mobile broadband,[3/] which is less than what is required to meet the critical wireless broadband needs for mid-band spectrum.[4/]

- Provide taxpayers with compensation for the expanded rights for the use of the public airwaves. Revenues from the auction would be divided between the U.S. Treasury and satellite operators, who would use some of the proceeds to pay for relocation of their customers. Under the satellite operators' proposal, they would retain all proceeds from the sale of spectrum and U.S. taxpayers would get nothing – an outcome directly contrary to the Communications Act's structure for making the public's spectrum available.[5/]

3/ With a total of 200 megahertz cleared to accommodate a 20 megahertz guardband. Press Release, *C-Band Alliance Increases to 200 MHz Its FCC Proposal for Spectrum Repurposing in the U.S. to Support Nationwide 5G Deployment*, C-Band Alliance (Oct. 22, 2018), https://c-bandalliance.com/wp-content/uploads/2018/10/C_Band_Alliance_Press_Release_22_October_2018_final.pdf ("C-Band Alliance Press Release").

4/ While the Commission has recently made spectrum in the lower and higher spectrum ranges available, it has recognized that this proceeding provides it with the best opportunity to "fill in gaps in the current broadband landscape" for mobile broadband providers by making mid-band spectrum available. *NPRM*, ¶ 3; *see also Policies Regarding Mobile Spectrum Holdings*, Report and Order, 29 FCC Rcd 6133, ¶ 18 (2014). The 3.7-4.2 GHz band provides a balance of capacity and coverage, and, because the band presents a contiguous spectrum block, it has the potential to accommodate the wide bandwidths associated with 5G technology. *NPRM*, ¶ 165. While T-Mobile appreciates the Commission making mid-band spectrum in the 3.5 GHz range available, that band alone is insufficient. There are significant limitations on use of the 3.5 GHz band due to incumbent operations that will remain in the band on a primary basis, the limited power available, and the use of an untested three tier sharing structure. Moreover, the available spectrum in the 3.5 GHz band is less mid-band spectrum than other countries are seeking to make available for 5G services and is insufficient to meet long-term mid-band mobile wireless broadband requirements. As the Commission notes, several countries already have designated some or all of the band for wireless mobile broadband. *NPRM*, ¶ 6. By 2020, nearly thirty countries, including Australia, Japan, and the majority of European countries, will have allocated at least some mid-band spectrum for terrestrial mobile services. *Id.*; *see also* Patrick Gahan, *Europe Leads in 3.5 GHz Assignments with Patchy Progress in Other Regions*, PolicyTracker, Mar. 9, 2018. In order to keep up with international efforts, the Commission should make the 3.7-4.2 GHz band available for licensed wireless use. In the race to 5G deployment, "U.S. leadership is the only acceptable option." Remarks of Chairman Ajit Pai at the Wireless Infrastructure Association Connectivity Expo (May 23, 2018), https://docs.fcc.gov/public/attachments/DOC-350919A1.pdf. And U.S. leadership requires the use of all potential spectrum bands.

5/ *See* 47 U.S.C. 309(j).

- Generate transparent market-based results. This is counter to the satellite operators' proposal to conduct a private auction with a limited number of buyers.

T-Mobile's proposal combines true free market mechanisms with the Commission's auction processes to present satellite licensees and potential terrestrial providers with a fully transparent way to determine the value of the 3.7-4.2 GHz band, backstopped with Commission rules that will result in transition of the band. T-Mobile's proposal would also allow both incumbents and taxpayers to share in the auction-generated revenues.

In order for any proposal that envisions full or partial clearing of the 3.7-4.2 GHz band to be successful, the Commission must have an accurate assessment of the current use of the spectrum. It can only do that through an additional information collection. Satellite providers should be required to validate the accuracy of the data provided by earth station registrants and licensees.

T-Mobile continues to disagree with requests to designate some or all of the 3.7-4.2 GHz band for point-to-multipoint ("P2MP") operations. The Commission has long abandoned spectrum allocation approaches that designate bands for particular technologies. If providers of P2MP services wish to secure use of the band, they can participate in the auction that T-Mobile proposes.

T-Mobile generally agrees with the service rules the Commission proposes for the 3.7-4.2 GHz band. The band should be licensed on an exclusive basis in 20 megahertz blocks on a Partial Economic Area ("PEA") basis with standard 10-year license terms. Power limits should be consistent with those the Commission adopted for use in the millimeter wave bands.

II. TO INCREASE THE INTENSITY OF TERRESTRIAL USE, THE COMMISSION SHOULD REPURPOSE THE BAND USING T-MOBILE'S MARKET APPROACH

A. T-Mobile's Proposed Market Approach Is a Straightforward Application of Prior Successful Commission Auctions.

T-Mobile's alternative market proposal would promote the availability of spectrum in all geographic areas and return some of the value of the spectrum to U.S. taxpayers. It would also allow satellite operators to receive payment for relinquishing and clearing spectrum through participation in an open and transparent auction process to efficiently determine the true value of the spectrum for satellite service relative to terrestrial mobile service. The proposal's core framework is a market-based auction with a decreasing amount of spectrum in each phase in which, similar to the satellite operators' proposal, a consortium comprised of all satellite licensees (the "satellite consortium") would be the seller and potential wireless providers would be the buyers. The plan, described further below, combines the attractive features of the satellite approach, while overcoming some of its limitations.

Phase 1 – Initial Price Setting for All 500 Megahertz. The first phase of the T-Mobile market plan would be a forward auction for licenses for all 500 megahertz of spectrum in each geographic area. T-Mobile proposes that the Commission auction the band on a PEA basis. In addition to PEAs, the auction would also include a limited number of license areas – rural locations defined by the satellite consortium as contiguous areas but not necessarily full PEAs – within which satellite operations could be protected from terrestrial wireless operations. Consistent with the relocation approaches discussed below, the satellite consortium would be able to define these areas outside population centers, where the demand for spectrum may be less. This would permit satellite operators to deliver signals to non-metropolitan earth stations from which communications could be transmitted via fiber or other means to urban centers.

Phase 2 – Satellite Consortium Opportunity to Sell All 500 Megahertz at the Market Clearing Prices. The second phase of the T-Mobile plan would permit the satellite consortium to sell the entire 500 megahertz of spectrum in each area at the price established in the initial phase for that area. The satellite consortium would be treated as a single reverse auction seller that would identify all of the geographic areas in which its members would vacate all 500 megahertz for the initial auction phase price (the cost of clearing the spectrum would be included in the satellite operators' calculation of whether it would vacate the spectrum for the prices offered). Those areas would be declared clear. All geographic areas for which 500 megahertz is not cleared would be included in the next phase of the auction.

Phase 3 – Price Setting for Decreasing Amounts of Spectrum in Uncleared Areas Followed by Reverse Auctions for Those Areas. During the third phase, the forward auction would continue for the remaining uncleared geographic areas, but now with some pre-designated amount of spectrum held out of the auction and reserved for satellite use in each of the remaining areas. The forward auction in this phase would begin at the ending price from the previous phase. The supply of spectrum in the forward auction would "step down" in increments, for example at 40 megahertz steps. So, the second forward auction phase would be for 460 megahertz in the remaining areas. The proposed amount of stepped-down spectrum would equal two terrestrial channel blocks and slightly more than a single satellite channel.

As before, after market-clearing prices are reached in the forward auction, a reverse auction stage would follow in which the satellite consortium would choose the areas in which all of its members would accept the forward auction price and vacate the spectrum. This process would repeat, each time reducing the amount of spectrum available for wireless use in each license area where the satellite consortium had not accepted the forward auction price in a

previous stage by 40 megahertz, until a Commission-determined minimum amount of spectrum per geographic area is reached (*see* Phase 4, below).

Phase 4 – Minimum Spectrum Phase. The final phase would be a forward auction stage only involving potential terrestrial mobile broadband licensees. Satellite companies would be *required* to vacate a Commission-designated minimum amount of spectrum in all remaining areas – even those self-defined by the satellite consortium – as long as a minimum clearing price, determined by the Commission, is received.[6/] Outside of satellite consortium defined areas, satellite providers should be required to make available no less than 300 megahertz (and would be able to retain 200 megahertz) of spectrum.[7/] In satellite consortium defined areas, satellite providers would be required to make 200 megahertz of 3.7-4.2 GHz spectrum available nationwide, leaving 300 megahertz for satellite use.

Assignment Round. After the phases above, there would be an assignment round similar to that in the 600 MHz incentive auction and millimeter wave auctions.

B. The Commission Can Repurpose the 3.7-4.2 GHz Band.

To increase terrestrial use of the 3.7-4.2 GHz band, the Commission proposes to either repurpose the band in a way that relocates the majority of incumbent services from the band using other spectrum or transmission services – the preferred alternative – or requires incumbent services to share the band with terrestrial mobile operations.[8/] Recognizing the challenges

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6/ We discuss below how the auction revenues could be shared between the federal government and the satellite providers in a way to provide additional incentives for the satellite providers and reduce the monopoly problem associated with the satellite operators' proposal. In contrast, the satellite operators' proposal would not result in any payments to the federal government, cutting taxpayers out of the auction process – a key component of a Commission-conducted auction.

7/ In certain instances – for example, in Alaska where satellite communications are uniquely critical to maintaining connectivity – satellite providers may retain more spectrum.

8/ *NPRM*, ¶¶ 66, 98, 110.

associated with co-channel sharing between FSS and mobile wireless operations in the same geographic area, the Commission seeks comment on whether such sharing would prevent most of the U.S. from having flexible fixed and mobile service in the 3.7-4.2 GHz band.[9/]

T-Mobile agrees that the Commission should not authorize sharing between terrestrial and FSS operations in the same geographic area on the same channels. Regulating unfettered access to the 3.7-4.2 GHz band by both terrestrial and FSS operations in the same geographic area, if feasible at all, would prove overly complex for the Commission to adopt and for terrestrial wireless providers and satellite incumbents to implement. Same-area frequency sharing is not technically possible because protecting satellite receivers from harmful interference from terrestrial emissions will require large separation distances that make sharing across the band infeasible – especially in urban areas where the need for wireless broadband capacity is greatest. Therefore, the band generally must be geographically repurposed. But repurposing the band does not mean that satellite users will be without competitive alternatives.

As discussed below, fiber can replace satellite use in many locations. Long-haul fiber infrastructure in the U.S. is robust and widely available, consisting of 273 cities, 2,411 links, and 542 conduits, by some estimates.[10/] And satellite providers can also take advantage of the expansive fiber-optic network at a relatively low cost.[11/] Satellite users also need not vacate the entire 3.7-4.2 GHz band everywhere. With the use of protection and coordination zones, earth stations outside of urban areas can continue to operate in the 3.7-4.2 GHz band without

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9/ *Id.* ¶ 52.

10/ Durairajan, *et al.*, *InterTubes: A Study of the US Long-haul Fiber-optic Infrastructure* (2015), http://pages.cs.wisc.edu/~pb/tubes_final.pdf.

11/ *Id.*

experiencing any disruption or diminution in service. In addition, there are cost-effective satellite options outside of the 3.7-4.2 GHz band that can be used as substitutes.

These alternatives can be used to clear all or most of the 3.7-4.2 GHz band across much of the nation's geography, while simultaneously meeting the requirements of the band's incumbents. Relocating satellite earth stations from urban areas to alternative facilities and using portions of the band outside of urban areas are both feasible and cost effective ways to make spectrum available for terrestrial wireless operations, as demonstrated through two case studies that are attached to this filing as Attachment A.[12/]

The first case study, which considers use of the 3.7-4.2 GHz band in the Phoenix, Arizona area (the "Phoenix Study"), shows that maintaining the same level of service with relocation to nearby geographic areas with less need for wireless broadband capacity is readily achievable. The Phoenix Study considered two options demonstrating the feasibility of clearing all earth station use within 60 kilometers of the Phoenix cellular market area ("CMA"). The first option examines a case in which a user has another receive-only earth station located farther outside of Phoenix and backhauls traffic from the farther station via fiber to the site of the current nearer station. The second option examines a situation in which a user does not have access to alternative facilities, so an antenna farm is created outside the Phoenix metropolitan area to support receive stations in the 3.7-4.2 GHz band, with traffic then backhauled to current earth station locations. The study shows the earth stations that would be affected by reallocating

12/ T-Mobile initially provided this analysis, along with its proposal for a hybrid market-based incentive auction, in June 2018. *See* Letter from Steve B. Sharkey, Vice President, Government Affairs, Technology and Engineering Policy, T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183, *et al.* (filed June 15, 2018).

the band for 5G wireless terrestrial use and demonstrates how traffic currently received at those earth stations could be reconfigured.

The second case study – conducted by Roberson and Associates, LLC – considers the use of the 3.7-4.2 GHz band in the Chicago area and shows that traffic received by earth stations in and around Chicago can be accommodated by relocation of the incumbent licensees in the band. The study suggests that there may be additional alternatives to continuing to receive content via backhauled satellite transmissions. For example, users could receive content through fiber links, bypassing the use of earth stations altogether. The study also identifies several fiber providers in the Chicago area, including many Internet service providers with networks offering wide coverage.

These case studies demonstrate that geographic separation of satellite and terrestrial use of the 3.7-4.2 GHz band can provide a cost-effective means of making the band available for broadband use without increasing harmful interference to incumbent operations. Terrestrial broadband equipment can operate in urban areas, where the demand for terrestrial services is highest, and satellite earth stations can operate in other areas.

C. The Satellite Proposal Is Flawed.

The Commission presents three primary methods of maximizing deployment of the band for flexible terrestrial use (and three sub-methods). First, it seeks comment on adopting the approach initially proposed by Intel, Intelsat, and SES Americom that would purportedly use market forces to create incentives for relocation.[13/] Under the Commission's articulation of that approach, satellite operators would voluntarily clear approximately 100 megahertz of spectrum and negotiate private secondary-market agreements with terrestrial mobile service providers

13/ *NPRM*, ¶ 66.

through a Transition Facilitator for access to specific spectrum blocks on a market-by-market basis. Terrestrial providers would then apply to the Commission for licenses authorizing them to provide service in the agreed-upon market areas and spectrum blocks.[14/] Proponents of this approach argue that it provides the quickest path to clearing the band for terrestrial wireless use.[15/] While an announcement by the C-Band Alliance increases the amount of spectrum made available for wireless broadband to 180 megahertz, the proposal is fundamentally the same as what is presented in the *NPRM*.[16/]

This satellite proposal acknowledges that, as T-Mobile demonstrates above, satellite users do not require use of the entire 3.7-4.2 GHz band. But it otherwise lacks critical components required to make the required amount of spectrum available for mobile wireless broadband. Most importantly, it would only provide assurance that less than one-half of the available spectrum would become available for mobile wireless broadband. That falls significantly short of what terrestrial operators need to deploy 5G broadband operations in the spectrum. As Nokia's CEO noted in an *ex parte* letter covering his meeting with Chairman Pai, "[t]he proposal of Intelsat and SES to unlock only 100 MHz of spectrum for 5G over 3 years is not sufficient to meet the needs of wireless operators**,** or to keep the U.S. competitive with the emerging 5G plans in China, Japan and Korea."[17/] Instead, he observed that "[t]he goal for the 3.7 GHz band should

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14/ *Id.* ¶ 81.

15/ *Id.* ¶ 67.

16/ *Id.* ¶¶ 66, 70. The C-Band Alliance now proposes that 180 megahertz be made available for mobile terrestrial operations (with a total of 200 megahertz cleared to accommodate a 20 megahertz guardband). *See* Press Release, *C-Band Alliance Increases to 200 MHz Its FCC Proposal for Spectrum Repurposing in the U.S. to Support Nationwide 5G Deployment*, C-Band Alliance (Oct. 22, 2018), https://c-bandalliance.com/wp-content/uploads/2018/10/C_Band_Alliance_Press_Release_22_October_2018_final.pdf.

17/ Letter from Jeffrey Marks, Government Relations, Nokia, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183, *et al.*, at 1-2 (filed May 22, 2018).

be to free 80 to 100 MHz of spectrum *per operator*, nationwide."[18/] T-Mobile agrees, particularly because of the wide bandwidths required to provide high data rate 5G services.

Terrestrial providers require a sufficient amount of spectrum for multiple operators to offer competitive services to meet the demand for applications that consume ever-increasing amounts of data. While making 180 megahertz of 3.7-4.2 GHz band spectrum available for terrestrial use, as proposed by the C-Band Alliance, is an incremental step in the right direction, that limited amount of spectrum will prove insufficient to generate the types of facilities-based competitive deployments of terrestrial 5G services capable of meeting or exceeding the performance and capabilities of systems now being introduced around the world.

The satellite operators' proposal also cuts taxpayers out of the equation. While satellite operators secured their spectrum at no cost, they will likely realize enormous returns from the sale of their spectrum. This result is unlike, for example, the broadcast incentive auction in which broadcasters received payment *and* taxpayers realized the benefit from the sale of the spectrum that reflected the enhanced transmission rights. Indeed, when spectrum has been repurposed from other uses – from fixed services, for example – the money that the terrestrial licensees paid was deposited into the U.S. Treasury (and, in most cases, terrestrial licensees were *additionally* required to reimburse costs of relocation to other frequencies or technologies).[19/]

18/ *Id.* (emphasis added).

19/ *See Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, First Report and Order and Third Notice of Proposed Rulemaking, 7 FCC Rcd 6886 (1992); *Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, Second Report and Order, 8 FCC Rcd 6495 (1993); *Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, Third Report and Order and Memorandum Opinion and Order, 8 FCC Rcd 6589 (1993); *Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, Memorandum Opinion and Order, 9 FCC Rcd 1943 (1994); *Redevelopment of Spectrum to Encourage Innovation in the Use of New Telecommunications Technologies*, Second Memorandum and Order, 9 FCC Rcd 7797 (1994).

Further, the private sale that the satellite operators contemplate is not likely to generate true market-based results. It does not assure wide participation from all potential mobile wireless broadband providers and otherwise does not represent a transparent market-based outcome. Indeed, the satellite operators state that they may enter into transactions with "one or more" potential wireless broadband providers.[20/] Nor does it easily support a potential range of outcomes in different geographic areas, which would enable a better balance of terrestrial and satellite use of the spectrum based on differing geographic needs. Instead, it contemplates a potential single transaction run by the satellite operators.

Because the satellite licensees together would have a monopoly and would be negotiating as a single entity, they would likely demand higher prices than a truly competitive market would support, which would make less than the socially optimal amount of spectrum available for terrestrial use. The Commission should therefore not allow satellite licensees to fully control the band. Any repurposing mechanism must eliminate or at least reduce the potential for monopoly pricing or actions by a single licensee (or coalition of licensees) to block access to the band. The satellite proposal fails on these counts.

D. T-Mobile's Proposal Will Produce Better Results for Mobile Broadband Providers and Taxpayers.

In contrast, T-Mobile's market approach would allow transparent market forces to operate by permitting satellite licensees to participate in a determination of the pricing and availability of spectrum for terrestrial wireless services, while curing several of the satellite proposal's most significant flaws. *First*, the Commission would be able to ensure an optimal market-based balance of spectrum for each service that reflects the varying requirements

20/ *See* Joint Comments of Intelsat License LLC and Intel Corporation, GN Docket No. 17-183, at 8 (filed Oct. 2, 2017).

between geographic areas. The minimum amount of spectrum sold would be determined by the Commission after a public interest assessment, not unilaterally determined by the satellite operators. *Second*, the Commission could split auction revenues between the federal government and the satellite licensees, allowing American taxpayers to benefit from the sale of spectrum that the satellite operators obtained for free. In exchange, the satellite licensees would be responsible for relocating and reimbursing their customers for costs incurred during the transition period. The satellite consortium would take those costs into consideration in its auction decisions.[21/]

However, the Commission must, as it has in the broadcast incentive auction, impose a schedule for relocation of incumbent operations out of whatever portion of the band is re-licensed at auction. That schedule should associate payment to the satellite consortium with band clearing to ensure prompt clearing of the band. While the satellite consortium may receive a down payment at the conclusion of the auction, it should not receive the majority of the payment until the auction winners have use of the spectrum.

The final way that the T-Mobile proposal is superior is its use of a transparent auction process that will better allow satellite operators to assess the value of their spectrum in particular geographic areas, with the benefit of multiple potential bidders. By revealing multiple terrestrial operators' highest bids for the 3.7-4.2 GHz band, starting with the highest level of clearing and incrementally falling to the lowest permitted level of clearing, satellite operators will be able to

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[21/] A particular way to split the revenues and, at the same time, create incentives for the sellers that would counteract the monopoly distortions of the satellite proposal would be for the Commission to use an "incentive schedule," where the fraction of the auction revenues that goes to the satellite consortium increases with the amount of spectrum they agree to sell in the auction. For example, if the satellite consortium does not agree to sell anything more than the minimum required amount in a given area, it would only receive sufficient revenue to cover clearing costs plus 10%. If the satellite consortium agrees to sell all of the 500 MHz in a given area, it could receive 80% of the revenue. And for intermediate amounts sold, it would receive an intermediate fraction of the revenues from the given area (for example, using a linear schedule). Such an incentive schedule (instead of a constant sharing rule) would make it more likely that the auction outcome would be efficient.

make better, more informed choices about their future use of the 3.7-4.2 GHz band. T-Mobile's approach also allows satellite operators to choose not only to clear the band or occupy it, but whether and to what extent to pursue geographic sharing mechanisms.

E. Other Proposed Auction Mechanisms Would Not Yield Optimal Results for Next Generation Wireless Services.

In addition to the satellite consortium's proposal and T-Mobile's alternative, the Commission seeks comment on three auction mechanisms – the overlay auction, the incentive auction, and the capacity auction – to expand flexible use of the band.[22/] In an overlay auction, the Commission would permit new operations in a geographic area, but would require the new licensee to ensure that its operations do not cause harmful interference to incumbent operations indefinitely.[23/] In an incentive auction, potential licensees bid against one another for the spectrum usage rights voluntarily sold by incumbents.[24/] Finally, in a capacity auction, a bidder in a reverse auction would give up some or all of their spectrum rights and lease those spectrum rights to other parties, allowing the lessees to use spectrum associated with specific transponders.[25/]

As explained above, T-Mobile's market approach – most similar to the Commission's proposed incentive auction – provides a true and transparent market mechanism that allows both incumbent FSS licensees and new terrestrial users to participate in the bidding process. But the Commission should reject the other two auction mechanisms it proposes as at once too risky and excessively proscriptive. An overlay auction presumes what the Commission recognizes is not

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22/ *NPRM*, ¶ 98.

23/ *Id.* ¶ 99.

24/ *Id.* ¶ 103.

25/ *Id.* ¶ 106.

feasible – that FSS and terrestrial use can occur on the same frequencies in the same geographic area. Therefore, overlay licenses may compromise the ability to implement new terrestrial use in the band – the primary objective of this proceeding. Even if overlay auctions permitted use of the band by both terrestrial and FSS operations through geographic separation, the use of the band would be wholly determined by FSS licensees with no Commission competitively determined level of terrestrial use, which is contrary to the public interest. As a result, the satellite operators will have the ability and incentive to impose restraints on the supply of spectrum for terrestrial operators.[26/] Those potential output limitations will frustrate the market and diminish investment in 5G broadband.

Overlay licenses would also create uncertainty about exactly what rights a licensee could obtain from an incumbent, which would likely dramatically reduce auction participation and auction revenues, as well as the investment in the band and resulting public benefit created by terrestrial use. Moreover, the Commission previously declined using an overlay auction in the 1.7 GHz band[27/] and, most recently, in the millimeter wave bands, specifically stated that an overlay auction would "delay the implementation of mobile service."[28/]

A capacity auction presents the same impediments – a general inability to share spectrum in the same geographic area and access controlled by incumbents with no Commission backstop.

26/ Satellite operators may choose to limit supply for several reasons, including to frustrate competition. Satellite companies have asserted that they also wish to provide broadband services, limiting access to wireless mobile broadband capacity. *See, e.g.*, Reply Comments of Telesat Canada, GN Docket No. 14-177, *et al.*, at 1 (filed Sept. 28, 2018) ("[V-band] satellite networks will support high-speed broadband services throughout the U.S., including in areas that are currently unserved and underserved, and will enhance competition for broadband services in other areas.").

27/ *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd 4610, ¶ 193 (2014).

28/ *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services et al.*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, ¶ 86 (2016) ("*Spectrum Frontiers Report and Order*").

III. THE COMMISSION SHOULD TAKE ADDITIONAL STEPS TO ENSURE THAT IT HAS AN ACCURATE ASSESSMENT OF INCUMBENT USE OF THE BAND

The success of any process to repurpose the 3.7-4.2 GHz band will depend on the Commission's ability to accurately assess the spectrum's current use. The Commission proposes several measures to help assess current incumbent operations in the 3.7-4.2 GHz band, and it seeks comment on proposals that would enable it to make the most informed decisions regarding mobile terrestrial use of the band.[29/] As the Commission notes, the comments in response to the *Mid-Band Notice of Inquiry*[30/] showed that the Commission needs up-to-date data about incumbent operations in the band, particularly with respect to the number of unregistered receive-only earth stations.[31/] Moreover, the comments explained that registered incumbent use of the band is both declining and overstated.[32/]

The Commission has taken an important first step toward achieving a better understanding of the state of the 3.7-4.2 GHz band by freezing applications for new or modified earth station and space station operations in the band.[33/] The Commission should permanently

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29/ *NPRM*, ¶¶ 26-46.

30/ *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 (2017).

31/ *NPRM*, ¶ 15.

32/ *Id.* ¶ 14; *see also* CTIA Comments, GN Docket No. 17-183, at 8-9 (filed Oct. 2, 2017) ("FSS rules designed to protect against interference are overprotective, contributing to the inefficient use of the band. This is due largely to the fact that earth station receive licensees in the band have access to much more spectrum than they use."); Comments of Verizon, GN Docket No. 18-122, at 1-2 (filed May 31, 2018) ("Currently, both the Fixed Satellite Service (FSS) and the terrestrial Fixed Service (FS) use the band, though neither—either on its own or collectively with the other—appears to fully use the band.").

33/ *See Temporary Freeze on Applications for New or Modified Fixed Satellite Service Earth Stations and Fixed Microwave Stations in the 3.7-4.2 GHz Band; 90-Day Window to File Applications for Earth Stations Currently Operating in 3.7-4.2 GHz Band*, Public Notice, DA 18-398 (rel. Apr. 19, 2018); *International Bureau Announces 90-Day Extension of Filing Window, to October 17, 2018, to File Applications for Earth Stations Currently Operating in 3.7-4.2 GHz Band, Filing Options for Operators with Multiple Earth Station Antennas*, Public Notice, DA 18- 639 (rel. June 21, 2018); *International Bureau Announces Temporary Filing Freeze on New Fixed Satellite Service Space Stations in the 3.7-4.2 GHz Band*, Public Notice, DA 18-640 (rel. June 21, 2018); *International Bureau Announces Two-Week*

freeze earth station and space station licensing in the band, as it proposes.[34/] A permanent freeze will preclude additional incumbent operations from encumbering otherwise unoccupied spectrum for terrestrial wireless use. A permanent freeze is particularly important if not all of the 3.7-4.2 GHz band is licensed for mobile broadband during the initial auction. The Commission's ability to license the remaining spectrum for mobile broadband will be compromised if it continues to permit expanded satellite use of the spectrum.

Recognizing that the process to clear the band must be informed by the most accurate assessment of the band's current use,[35/] the Commission proposes to require earth station operators to file additional information – such as geographic location, antenna gain, azimuth and elevation gain pattern, and transponder data – for each antenna under each call sign.[36/] T-Mobile agrees that the Commission must take these steps to ensure the accuracy of the International Bureau Filing System ("IBFS") database.[37/] The additional proposed information collection is necessary because the freeze and the certification processes adopted are not enough to show exactly how the band is used. The freeze merely retains in place the current licenses – whether or not they represent ongoing operations. Certification omits the types of detailed operating parameters necessary for policymakers to assess the preclusive effect of satellite earth stations on terrestrial 5G deployments. The certification, as required by the *Order*,[38/] may also not show

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Extension of Filing Window for Earth Stations Currently Operating in 3.7-4.2 GHz Band, Public Notice, DA 18-1061 (rel. Oct. 17, 2018).

34/ *NPRM*, ¶¶ 30, 46.

35/ *Id.* ¶ 16 ("It is important that we obtain a clear understanding of the operations of current users in the band. This user data will be vital to our consideration of how much spectrum could be made available, how incumbent operators could be protected, accommodated, or relocated, and the overall structure of the band going forward.").

36/ *Id.* ¶ 41.

37/ *See id.*

38/ *Id.*

how incumbents actually use the spectrum, particularly in light of the full-band, full-arc policy. In contrast, the proposed information collection enhances transparency, and will enable the Commission to develop a more complete understanding of the utility of the band for incumbents and proposed mobile broadband services. Once the Commission receives the responses, it should remove uncertified earth stations from the database and eliminate any obligations on future wireless licensees to protect those stations against harmful interference.

The Commission should also eliminate the full-band, full-arc coordination policy, as it proposes,[39/] which will also more accurately depict the band's current Fixed Satellite Service ("FSS") use.[40/] The policy, which authorizes registered or licensed earth stations to use the entire 3.7-4.2 GHz band, regardless of their required capacity, causes use of the band to be overstated. Without information about actual demands, the policy results in the issuance of licenses that reserve more spectrum resources than are needed, either now or in the immediate future. The information collection the Commission proposes should take into account the elimination of the policy.

In addition to the foregoing steps, T-Mobile urges the Commission to require *satellite operators* to confirm the certifications and information provided by earth station users pursuant to the *Order* and rules adopted as a result of the *NPRM*.[41/] Under many of the proposals to enhance terrestrial use of the band – including T-Mobile's – satellite operators will be responsible for relocating earth station operators. Therefore, they must affirm representations by

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39/ *Id.* ¶¶ 39-40.

40/ Assuming that the current freeze remains in effect, the elimination of the full-band, full-arc policy with respect to current earth station users, in combination with certifications from existing users regarding the scope of their operations, will allow the Commission to secure a more accurate assessment of spectrum use.

41/ *NPRM*, ¶ 41.

earth station users. Moreover, satellite operators are in the best position to determine whether the information the Commission receives is accurate. Earth station users have no independent ability to use satellite capacity – those rights are based solely on agreements with satellite operators.[42/] If an earth station operator has no relationship with a satellite provider, it should not have any rights for protection because terrestrial usage would not interfere with its (non) use of the license. Confirmation from satellite operators would therefore be a meaningful check of the accuracy of information provided by earth station users.

The Commission seeks comment on sunsetting point-to-point use in the band and transitioning incumbent operations over a period of time, given the limited use of the band for point-to-point Fixed Service ("FS") operations, and the ability to deploy point-to-point links in other bands.[43/] There is little disagreement among stakeholders over the Commission's determination that FS operations in the band have steadily declined for the last two decades.[44/] The Commission should therefore sunset FS operations, both permanent and temporary. The time frame for sunsetting should be the same as the period for FSS clearing of the band.

IV. THE COMMISSION NEED NOT DESIGNATE SOME OR ALL OF THE BAND FOR POINT-TO-MULTIPOINT USE

The Commission seeks comment on authorizing fixed P2MP use in the 3.7-4.2 GHz band, partially in response to the Broadband Access Coalition's Petition for Rulemaking.[45/] The

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42/ *See* 47 CFR § 2.106. The 3.7-4.2 GHz band is currently allocated for non-federal fixed and FSS use on a primary basis.

43/ *NPRM*, ¶ 48.

44/ *See, e.g.*, Comments of the Fixed Wireless Communications Coalition, GN Docket No. 18-122, at 2 (filed May 31, 2018).

45/ *NPRM*, ¶ 116; Broadband Access Coalition, Petition for Rulemaking to Amend and Modernize Parts 25 and 101 of the Commission's Rules to Authorize and Facilitate the Deployment of Licensed Point-to-Multipoint Fixed Wireless Broadband Service in the 3700-4200 MHz Band, RM-11791 (filed June 21, 2017).

Commission should reject the Broadband Access Coalition's petition and decline to designate any portion of the 3.7-4.2 GHz band for any particular wireless technology. Limiting spectrum to a single use case is contrary to the public interest and the Commission's practice to allow licensees to provide a variety of services.[46/] Instead, the spectrum should be flexibly allocated and licensed on a geographic area basis so that licensees can acquire spectrum and employ the spectrum in the manner they believe will be most productive – whether it is P2MP or mobile use.

The Broadband Access Coalition may wish that the Commission designate some of the 3.7-4.2 GHz so that its members are not required to compete against other applicants in a statutorily mandated auction.[47/] But while the Communications Act directs the Commission to use engineering solutions to avoid mutually exclusive applications,[48/] it does not require the Commission to avoid mutually exclusive applications by abandoning the sound spectrum management practices of flexible spectrum use. That is precisely the outcome that the Broadband Coalition seeks. But if its members wish to use spectrum for P2MP use, then they should be required to participate in an auction like others that propose to use spectrum for commercial purposes.

Even if spectrum policy favored setting aside spectrum for unique applications, neither the Broadband Access Coalition nor any other P2MP user has demonstrated why this band is

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46/ *Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services*, Sixteenth Report, 28 FCC Rcd 3700, ¶ 102 (2013) ("[T]he Commission has adopted a general policy of providing licensees with significant flexibility to decide which services to offer and what technologies to deploy on spectrum used for the provision of mobile wireless services"); *Expanding Access to Broadband and Encouraging Innovation Through Establishment of an Air-Ground Mobile Broadband Secondary Service for Passengers Aboard Aircraft in the 14.0-14.5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd 6765, ¶ 101 (2013) (the Commission "strive[s] to establish technology neutral rules that allow for competing technologies and changes in technology over time without the need to change our rules").

47/ 47 U.S.C. 309(j).

48/ 47 U.S.C. 309(j)(6)(E).

critical for P2MP use. On the other hand, the need to designate the band for wireless broadband because of international considerations and the need for additional mid-band spectrum is well documented. The premise for additional P2MP use – that it can be successfully shared with satellite services – is contrary to what should be the principal purpose of this proceeding, which is to clear the band of satellite operations to the maximum extent feasible so that the band can be used for 5G wireless broadband services. Sound spectrum management dictates that the Commission consider the best and highest possible use of the band. It would be short-sighted to adopt rules permitting greater P2MP use of the band today only to later conclude that those rules have made it problematic to have mobile services in the band.

Adoption of flexible rules with geographic area licenses, however, can satisfy the interests of multiple stakeholders. Flexible rules will permit the deployment of a range of potential uses and terrestrial technologies in the band, including mobile broadband and the fixed and P2MP operations for which others advocate. Consistent with recent Commission precedent,[49/] the Commission should designate spectrum for flexible use and conduct an auction, as the Communications Act requires, to license the spectrum if there are mutually exclusive applications. That approach permits licensees to use the spectrum purchased at auction as they deem best, so long as that use is consistent with the adopted operating and technical rules and protects operations in adjacent bands.

49/ *See Spectrum Frontiers Report and Order*, ¶ 77 ("The Commission recognized that given the convergence between fixed and mobile technologies, attempting to define separate bundles of fixed and mobile rights might create unnecessary complexity and be inconsistent with the underlying technologies."); *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band,* Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959, ¶ 44 (2015) ("By adopting a flexible access model across the entire band, we aim to create a versatile 150 megahertz band for shared wireless broadband use that can adapt to market and technological opportunities.").

V. SERVICE RULES FOR FLEXIBLE USE OF THE BAND

A. Band Plan

Block Sizes. The Commission seeks comment on the appropriate block size for the 3.7-4.2 GHz band and whether the particular transition mechanism that it adopts will influence the block size.[50/] The Commission should license the band in 20 megahertz blocks, which are sufficiently large to support a variety of wireless broadband technologies. Blocks could be aggregated to support applications that require wider bandwidths.[51/]

Even though the Commission generally plans to license the millimeter wave bands by 100 megahertz channels,[52/] the 3.7-4.2 GHz band should be treated differently for three reasons. *First*, there is simply less spectrum available in the mid-band, and the Commission should create opportunities for multiple licensees. In the millimeter wave bands, there are multiple bands with sizeable amounts of spectrum available. *Second*, it is possible that not all 500 megahertz at 3.7-4.2 GHz will be available for mobile broadband use immediately,[53/] further compelling the use of smaller licenses to create opportunities for multiple licensees to hold spectrum in each area. The 3.5 GHz band, and potentially the 3.7-4.2 GHz band, are presently the only mid-band spectrum

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50/ *NPRM*, ¶¶ 135-36.

51/ If at least 200 megahertz of spectrum will be auctioned, the Commission could license the band in 40 megahertz or 50 megahertz blocks.

52/ *See Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al.*, GN Docket No. 14-177 *et al.*, Fourth Further Notice of Proposed Rulemaking, FCC 18-110, ¶ 10 (rel. Aug. 3, 2018) ("*Spectrum Frontiers Fourth Further Notice*"); *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al.*, GN Docket No. 14-177 *et al.*, Third Report and Order, Memorandum Opinion and Order, Third Further Notice of Proposed Rulemaking, FCC 18-73, ¶ 28 (rel. June 8, 2018) (subparts referred to respectively as *Spectrum Frontiers Third Report and Order* or *Spectrum Frontiers Third Further Notice*); *Use of Spectrum Bands Above 24 GHz For Mobile Radio Services, et al.*, Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, 32 FCC Rcd 10988, ¶ 35 (2017).

53/ The 3.7-4.2 GHz band has "500 megahertz of contiguous spectrum to accommodate twenty-five 20 megahertz channels." *NPRM*, ¶ 116.

available for 5G wireless broadband, and, as the Commission has recognized, mid-band spectrum is important for network deployment.[54/] *Finally*, 3rd Generation Partnership Project ("3GPP") standards envision larger bandwidths in the millimeter wave band[55/] but smaller channel sizes in mid-band spectrum.[56/] The Commission should make block sizes 20 megahertz wide to be consistent with the work that 3GPP is performing in this and the other mid-band spectrum to ensure that its proposed band plans are consistent with those developed by international standards-setting entities.

Spectrum Block Configuration. The Commission seeks comment on how it should configure spectrum blocks in the 3.7-4.2 GHz band.[57/] Specifically, it asks whether the band should be licensed on a paired basis to support mobile broadband services.[58/] It need not. T-Mobile urges the Commission to auction the spectrum blocks on an unpaired basis, which will create the maximum flexibility for use.[59/] Creating unpaired spectrum blocks will also provide the Commission with more flexibility if it permits continued use of some part of the band for FSS operations.

54/ *NPRM*, ¶ 4. While the Commission recently acted to greatly improve the utility of the 3.5 GHz band, the shared nature of the band and limited power levels mean that it is not a substitute for full power, exclusively licensed spectrum. *See Promoting Investment in the 3550-3700 MHz Band*, Report and Order, FCC18-149 (rel. Oct. 24, 2018).

55/ *See Spectrum Frontiers Fourth Further Notice* ¶ 10, n.27 (noting that "100 megahertz channels are supported in the 3GPP's 5G specifications for the 39 GHz band").

56/ Letter from Steve B. Sharkey, Vice President, Government Affairs, Technology and Engineering Policy, T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183, *et al.*, Attachment at 7-8 (filed Oct. 13, 2017) ("Of course, 5G specifications will cover many frequency bands beyond those around 3.5 GHz, but it is reasonable to assume that 40 or 50 MHz channels may be specified in this band for mobile broadband services.").

57/ *NPRM*, ¶ 137.

58/ *See id.*

59/ *Spectrum Frontiers Report and Order*, ¶ 96.

Use of Geographic Licensing. The Commission proposes to license the band on an exclusive, geographic area basis.[60/] T-Mobile agrees with this proposal. Exclusively licensed commercial spectrum is the basis for today's robust mobile broadband ecosystem. Wireless carriers have made and continue to make massive investments in licensed spectrum based on the certainty of continued access to spectrum and the ability to maximize its efficient use,[61/] and these investments have facilitated the creation of networks capable of supporting greater speeds and functionalities and have led to new, more powerful and sophisticated devices. Licensed spectrum is also a critical economic driver.[62/]

Service Areas. The Commission seeks comment on the appropriate service area for flexible use licenses.[63/] As noted above, T-Mobile recommends that the Commission issue geographic area licenses in the band on a PEA basis with limited exclusion areas for continuing intensive satellite operations. In almost all recent cases, the Commission has created PEA-based license areas.[64/] Nevertheless, as it did in the 3.5 GHz proceeding, T-Mobile is willing to

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60/ *NPRM*, ¶ 138.

61/ Wireless carriers have made over $226 billion in capital investments since 2010. *See State of Wireless 2018*, CTIA, https://api.ctia.org/wp-content/uploads/2018/07/CTIA_State-of-Wireless-2018_0710.pdf (last accessed Aug. 30, 2018).

62/ Every 100 megahertz of licensed spectrum made available adds $31 billion to the U.S. Gross Domestic Product and supports approximately 1 million new jobs. *See $31 Billion U.S. GDP and 1 Million Jobs Added by Wireless Industry for Every 100 MHz Licensed*, Press Release, CTIA (Jan. 26, 2016), https://www.ctia.org/news/31-billion-u-s-gdp-and-1-million-jobs-added-by-wireless-industry-for-every-100-mhz-licensed-spectrum; *see also Licensed Spectrum: The Key to Continuing America's Wireless Leadership and Growing our Economy*, CTIA (Feb. 2017), https://api.ctia.org/docs/default-source/default-document-library/ctia-white-paper-licensed-spectrum.pdf.

63/ *NPRM*, ¶ 139.

64/ *See Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 29 FCC Rcd 6567, ¶ 71 (2014) (adopting PEAs as the service area for the 600 MHz band licenses); *see* 47 C.F.R. § 30.5 (establishing PEAs as the service area in the 24 GHz, Upper 37 GHz, 39 GHz, and 47 GHz bands); *Spectrum Frontiers Third Further Notice*, ¶ 89 (seeking comment on adopting PEAs as the service area for UMFUS licenses in the 26 GHz band). Except for in the 28 GHz band, the Commission has either adopted or proposed to adopt rules that would make PEAs the license area for millimeter wave spectrum. Because licenses in that band were initially issued by

consider geographic solutions that maximize terrestrial use of the band while preserving satellite operations mostly outside urban areas.

B. Licensing and Operating Rules

Eligibility. The Commission proposes an open eligibility standard for the band to encourage the development of new technologies, products, and services.[65/] Consistent with its approach to licensing other commercial spectrum, T-Mobile agrees that the band should be open to any prospective licensee that meets the basic Commission qualifications to be eligible to apply for a license.

License Term. The Commission seeks comment on a 15-year license term for the band.[66/] While T-Mobile agrees with the Commission that sufficient time is required for licensees to meet their build out obligations, licensees cannot be permitted to warehouse spectrum. Therefore, the Commission should adopt the standard 10-year license term, consistent with other mobile broadband services.[67/] Ten years is necessary to permit entities to take all of the steps required – developing and optimizing technology and securing antenna siting – to provide a robust service. Given the international interest for using this band for 5G, we anticipate rapid development of both infrastructure and device ecosystems.

Basic Trading Areas, which do not easily realign with PEAs, the Commission declined to also use PEA licensing for that spectrum. *See Spectrum Frontiers Report and Order*, ¶ 82. However, in other bands, the Commission should attempt to create a consistent licensing scheme using PEAs. In the 3.5 GHz band, the Commission has imposed a unique, three-tier use structure where PEAs are not practical.

65/ *NPRM*, ¶ 145.

66/ *Id.* ¶ 149.

67/ Local Multipoint Distribution Service licenses, 39 GHz licenses, and all UMFUS licenses have 10-year license terms. *Spectrum Frontiers Report and Order*, ¶¶ 174-76.

Performance Requirements. The Commission seeks comment on whether it should require licensees to meet population-based performance benchmarks.[68/] Specifically, it asks whether mobile or P2MP service would be required to provide reliable signal coverage to at least 45% of the population within 6 years, and to at least 80% of the population within 12 years. Under the Commission's proposal, after the 12-year performance benchmark, a licensee would be required to continue to provide reliable signal coverage at or above that level for the remaining three years in the proposed license renewal. If the population within the license area is equal to or less than 268,000, a point-to-point licensee would be required to demonstrate four links operating and providing service within six years. If the population within the license area is greater than 268,000 persons, a point-to-point licensee would be required to demonstrate that it has at least one link in operation and is providing service per every 67,000 persons.

Performance requirements should be set at the end of the license term – as with other licensed services – and at an interim point. Consistent with the performance requirements

68/ *NPRM*, ¶ 151.

adopted in the H Block,[69/] AWS-3,[70/] AWS-4,[71/] and millimeter wave bands,[72/] the Commission should use a 40% performance requirement at the four-year mark, and 75% at the end of a ten-year license term. Like the Commission's previously adopted population-based performance requirements, the proposed performance requirements are appropriate here because they will encourage timely deployments of 5G technologies while also providing enough flexibility that will allow licensees to tailor their deployments to specific market demands. Because at least some of the applications for the band will be focused on small-cell deployment and may be used to enhance capacity,[73/] population-based coverage requirements are most appropriate.

Internet of Things Performance Requirements. The Commission seeks comment on whether Internet of Things ("IoT") type services may benefit from alternative performance benchmarks.[74/] To fulfill their buildout requirements, flexible use spectrum licensees would be

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69/ *Service Rules for Advanced Wireless Services H Block—Implementing Section 6401 of the Middle Class Tax Relief and Job Creation Act of 2012 Related to the 1915-1920 MHz and 1995-2000 MHz Bands*, Report and Order, 28 FCC Rcd 9483, ¶ 195 (2013) ("We therefore adopt performance requirements that will ensure the rapid deployment of wireless service in the H Block, while giving licensees sufficient flexibility to deploy services according to their business plans.").

70/ *Amendment of the Commission's Rules with Regard to Commercial Operations in the 1695-1710 MHz, 1755-1780 MHz, and 2155-2180 MHz Bands*, Report and Order, 29 FCC Rcd 4610, ¶ 135 (2014) ("*AWS-3 Report and Order*"); *see also AWS-3 Report and Order*, ¶ 138 ("Requiring AWS-3 licensees to meet these performance benchmarks will promote rapid deployment of new broadband services to the American public, and at the same time provide licensees with certainty regarding their construction obligations.").

71/ *Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands, et al.*, Report and Order and Order of Proposed Modification, 27 FCC Rcd 16102, ¶ 187 (2012) ("For the AWS-4 band, we adopt performance requirements that will ensure that the spectrum is put to use expeditiously, while providing licensees with the flexibility needed to deploy services according to their business plans.").

72/ *See, e.g., Spectrum Frontiers Report and Order*, ¶ 206 (adopting the 40% performance requirement in the millimeter wave bands) (finding that the population-based performance requirements "strike[] the appropriate balance between ensuring sufficient use of the spectrum and allowing licensees flexibility to deploy an emerging technology.").

73/ *See The FCC's 5G FAST Plan*, FCC, https://www.fcc.gov/5G (last visited Oct. 29, 2018).

74/ *NPRM*, ¶¶ 154-55.

required to demonstrate geographic area coverage of at least 35% within six years, and geographic coverage of at least 65% within 12 years.[75/] In the *Third Report and Order* in the *Spectrum Frontiers* proceeding, the Commission adopted performance requirements aimed at IoT and similar applications.[76/] The performance obligations for IoT should be similar in the 3.7-4.2 GHz band. In any event, because IoT applications are still developing, the Commission should also accept alternative demonstrations of performance.

Penalty for Failure to Meet Performance Requirements. The Commission seeks comment on whether licensees should be subject to enforceable penalties for failing to meet performance benchmarks.[77/] If a licensee fails to meet the first benchmark, the Commission proposes that both the second benchmark and the license term be reduced by two years.[78/] And if the licensee fails to meet the second benchmark, the Commission proposes that the authorization for each license where it fails to meet the performance requirement automatically terminates.[79/] T-Mobile agrees that licensees should be subject to enforceable penalties for failing to meet performance benchmarks and with the proposed penalties. The Commission must ensure that the 3.7-4.2 GHz spectrum is actually being used and must revoke licenses when it is not. However, it is overly punitive for the Commission to cancel an entire license if a provider is serving customers in part of the license area, but not in others. Accordingly, licensees should not lose rights to an entire license when they are unable to meet the performance requirements. Instead,

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75/ *Id.* ¶ 155.

76/ *Spectrum Frontiers Third Report and Order*, ¶ 9 (adopting a geographic area performance metric as an option for UMFUS licensees with IoT-type services).

77/ *NPRM*, ¶ 157.

78/ *Id.*

79/ *Id.*

they should be able to retain areas where service is being provided. Un-retained areas can then be subject to re-licensing to other providers that believe they can provide service in those areas.

Compliance Procedures. The Commission proposes to require licensees to file electronic coverage maps showing the boundaries of each license area in the licensee's service territory and the boundaries of the areas within each license area not being served.[80/] The Commission also proposes to require licensees to submit documentation certifying the type of service they are providing in each licensed area within the service territory and the type of technology used to provide such service.[81/] T-Mobile agrees with this proposal, subject to two conditions. *First*, the Commission should base proof of coverage on the covered population and not on coverage area, as proposed above. As noted above, at least some of the applications for the band will be focused on small-cell deployment and may be used to enhance capacity. Geographic-based requirements, in contrast, would be incompatible with small-cell deployment in the band and may inhibit certain innovative uses. *Second*, the Commission should require the submission of coverage maps no more than twice during the license term as part of build-out reports. Providing coverage maps is a time-consuming process. While the Commission should ensure that spectrum is being used, it must balance that need against imposing unreasonable burdens on licensees.

Renewal Term Construction Obligations. The Commission seeks comment on applying renewal term construction obligations,[82/] consistent with those adopted in its recent *Renewal*

80/ *Id.* ¶ 159.

81/ *Id.*

82/ *Id.* ¶¶ 160-61.

Reform proceeding.[83/] T-Mobile urges the Commission to use the recently adopted renewal framework in order to ensure consistency across services.

Competitive Bidding Procedures. The Commission proposes to use its Part 1 competitive bidding procedures if the Commission auctions some or all of the band.[84/] T-Mobile agrees with this proposal.

General Part 27 Rules. The Commission proposes that licensees comply with the licensing and operating rules applicable to all Part 27 services, including the rules for foreign ownership reporting, partitioning and disaggregation, and spectrum leasing.[85/] In order to promote consistency in the rules, the Commission should also generally extend the Part 27 regulations to the 3.7-4.2 GHz band.

C. Technical Rules

Power Limits for Fixed and Base Stations. The Commission seeks comment on whether it should extend the current rules for AWS-1, AWS-3, and AWS-4 limit base station power to fixed base stations – 1640 watts equivalent isotropically radiated power limit ("EIRP") for emission bandwidths less than one megahertz and to 1640 watts per MHz EIRP for emission bandwidths greater than one megahertz.[86/] For operation in rural areas, the Commission proposes power limits of 3280 watts EIRP for emission bandwidths less than one megahertz and

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83/ *See Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 To Establish Uniform License Renewal et al.*, Second Report and Order and Further Notice of Proposed Rulemaking and Order, 32 FCC Rcd 8874 (2017).

84/ *NPRM*, ¶ 163.

85/ *Id.* ¶ 134.

86/ *Id.* ¶ 164.

to 3280 watts per MHz EIRP for emission bandwidths greater than one megahertz.[87/] T-Mobile supports this proposal in order to have consistent technical limits across bands, where feasible.

Power Limits for Mobile and Portable Devices. The Commission seeks comment on whether it should limit the power of mobile and portable devices to 1 Watt (30 dBm).[88/] T-Mobile urges the Commission to increase the EIRP beyond 30 dBm so that it is sufficiently high for robust deployment of 5G technologies and accurately reflects real-world deployments. Because it is expected that the Commission will license the band by 20 megahertz channels, and that spectrum larger than 20 megahertz channels will be available in the band through aggregation, T-Mobile suggests that the Commission adopt an EIRP limit of 43 dBm/100 MHz – the same EIRP limit as it adopted in the millimeter wave bands.[89/]

Out of Band Emission Limits. The Commission seeks comment on its proposal to apply the out of band emission limit of -13 dBm/MHz at the authorized channel edge as measured at the antenna terminals, and whether this limit would apply to both base stations and mobile handsets.[90/] The Commission also seeks comment on whether it should adopt more stringent out of band emission limits beyond the edges of the band.[91/] The Commission should adopt the -13 dBm/MHz out of band emission limit at the channel edge, which will accommodate the wider bandwidths needed for 5G. More stringent emission limits will diminish the utility of the band and threaten coverage.

87/ *Id.*

88/ *Id.* ¶ 167.

89/ *Spectrum Frontiers Report and Order*, ¶ 283.

90/ *NPRM*, ¶ 168.

91/ *Id.* ¶ 169.

Coexistence with Adjacent Band FSS Operations. The Commission seeks comment on whether it should adopt additional protection criteria to ensure coexistence with adjacent band FSS operations.[92/] No additional protection is required for adjacent band operations, although, as T-Mobile has stated in the past, the Commission may wish to continue to study whether terrestrial wireless services would interfere with wireless avionics intra-communications ("WAIC") and radio altimeter operations in the 4.2-4.4 GHz band.[93/] T-Mobile supports the safe operation of WAIC and radio altimeters and urges the Commission to work with other federal agencies, such as the National Telecommunications and Information Administration and the Federal Aviation Administration, to determine an appropriate technical framework to allow mobile use at 3.7-4.2 GHz without causing harmful interference to properly engineered adjacent aviation operations. The Commission should ensure that WAIC systems are engineered recognizing the potential for adjacent channel operations.

Coexistence with In-Band FSS Operations. Recognizing that some earth stations may remain after some or all of the band is converted to flexible use, the Commission seeks comment on whether it should adopt exclusion zones or coordination zones to protect those FSS operations.[94/] Protection zones between satellite earth stations and terrestrial wireless services are necessary to avoid harmful interference. It may be possible to preserve satellite use in rural areas with coordination zones. A limited number of earth stations in rural areas, under appropriately structured rules, should have limited impact on mobile wireless broadband systems. If some earth stations remain in the band, the Commission should impose geographic

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92/ *Id.* ¶ 172.

93/ Reply Comments of T-Mobile USA, Inc., GN Docket No. 18-122, at 8 (filed June 15, 2018).

94/ *NPRM*, ¶ 176.

separation requirements between satellite earth stations and terrestrial base facilities. Those separation requirements should be calculated by taking into consideration all available technical solutions that may be used by terrestrial licensees, such as filtering, shielding, directional antennas, etc. Similarly, separation distances must take into consideration the characteristics of the earth stations, wireless configuration, and terrain, and earth stations constructed or upgraded as part of a relocation program should be configured to limit the amount of separation needed. Because the extent of the necessary protection zones will vary based on these characteristics, the Commission should allow the parties involved to determine the appropriate separation distance.

Coexistence with FSS Operations Below 3700 MHz. The Commission seeks comment on whether it should include operators of FSS earth stations authorized in the 3600-3700 MHz band in any transition mechanism that it adopts, including possible relocation.[95/] The Commission also seeks comment on whether RF shielding would be sufficient to protect FSS earth stations below 3700 MHz.[96/] The Commission need not take any further actions aside from those proposed in the *NPRM* to protect FSS operations below 3700 MHz.

Coexistence with Telemetry, Tracking, and Command. The Commission considers coexistence with telemetry, tracking, and command ("TT&C") receiver earth stations near 3700 MHz, 3950 MHz, and 4200 MHz.[97/] The Commission seeks comment on the coexistence criteria needed for TT&C earth stations and how they are different from other earth station receivers.[98/] Since the number of TT&C earth stations in the 3.7-4.2 GHz band is minimal, T-Mobile

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95/ *Id.* ¶ 177.

96/ *Id.* ¶ 179.

97/ *Id.*¶ 180.

98/ *Id.*

recommends protection on a case-by-case basis through coordination between flexible use spectrum licensees and FSS earth station operators.

Coexistence with the Citizens Broadband Radio Service. The Commission considers coexistence with the Citizens Broadband Radio Service ("CBRS") operations in the 3.5 GHz band, including the suitability of the proposed out of band emission limit.[99/] There are no demonstrated compatibility concerns with CBRS operations in the 3.5 GHz band and proposed terrestrial use of the band. Therefore, no additional protection requirements for CBRS operations are required.

Field Strength Limit and Market Boundaries. The Commission proposes to adopt the same -76 dBm/m2/MHz power flux density limit at the service area boundaries that it used for the Upper Microwave Flexible Use Service in the millimeter wave bands.[100/] T-Mobile urges the Commission to adopt the -76 dBm/m2/MHz power flux density limit in order to promote consistency with other 5G bands.

Antenna Height Limits. The Commission proposes to apply the AWS-1 and AWS-3 flexible antenna height rules to the flexible use spectrum in the band.[101/] All Part 27 services are subject to Section 27.56, which bans antenna heights that would be hazardous to air navigation. The Commission proposes that no unique antenna height limits are needed for the band.[102/] T-Mobile agrees.

99/ *Id.* ¶ 181.

100/ *Id.* ¶ 184.

101/ *Id.* ¶ 186.

102/ *Id.*

VI. CONCLUSIONS

T-Mobile commends the Commission's efforts to make additional spectrum available for mobile broadband services. The 3.7-4.2 GHz band will be critical to 5G networks. T-Mobile's proposal to use a market-based Commission auction is the best way to ensure that adequate spectrum is made available, that taxpayers share in the auction revenues, and that spectrum is made available through a true and transparent market-based approach.

Respectfully submitted,

/s/ *Steve B. Sharkey*
Steve B. Sharkey
John Hunter
Christopher Wieczorek

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October 29, 2018

Attachment A

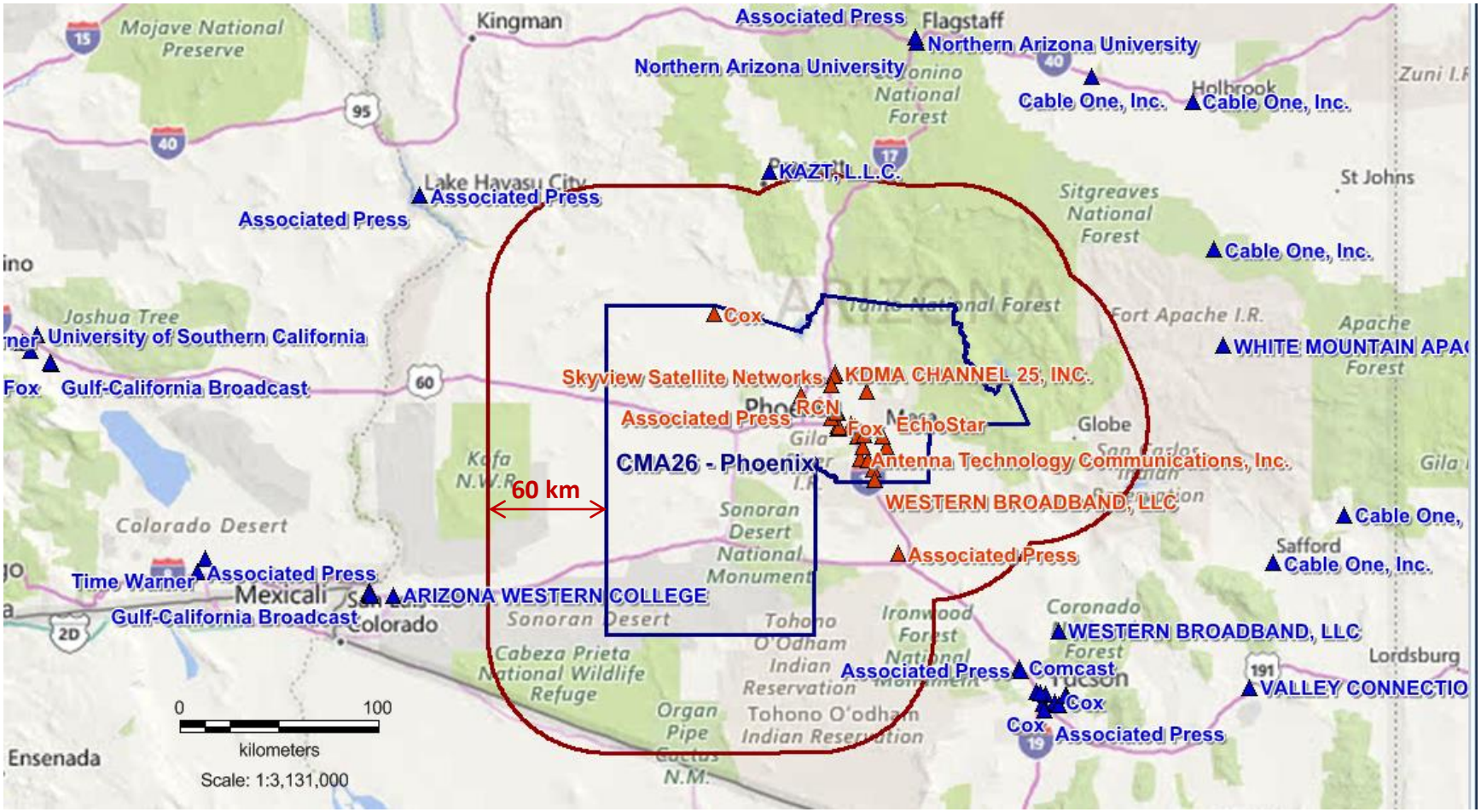
Phoenix Earth Station Relocation Study

May 30, 2018

Phoenix Case Study

- There are studies in the record that demonstrate the separation distance required between IMT base stations and C band earth stations to prevent interference to earth stations
  - Ericsson filed a study on October 2, 2017 that concluded a minimum separation distance of 30 kilometers would be required, and as high as 50 – 70 kilometers for more stringent I/N assumption and lower earth station elevation angles
  - SES filed a study on March 2, 2018 which confirmed Ericsson's results by showing that the distance required to protect five earth stations from a single base station in the Virginia Beach area was 30-40 kilometers
- Both studies considered earth stations in urban and suburban areas
- Neither study considered additional commonly-applied mitigation techniques such as shielding that could reduce the separation distance required
- Neither study contemplated moving urban and suburban base stations to rural areas
- To understand the feasibility of relocating C band earth stations and the requirements for doing so, the following study contemplates relocating all earth stations within 60 kilometers of the Phoenix CMA border to more remote locations outside the CMA
  - This would free up the entire 500 MHz of the C band for wireless broadband use in the entire CMA
  - This is an overly conservative approach that may be modified for other markets

Phoenix C Band Earth Stations



Relocation of 33 licensed earth stations within 60 kilometers of the Phoenix CMA (orange triangles) frees up 500 MHz of spectrum in the CMA

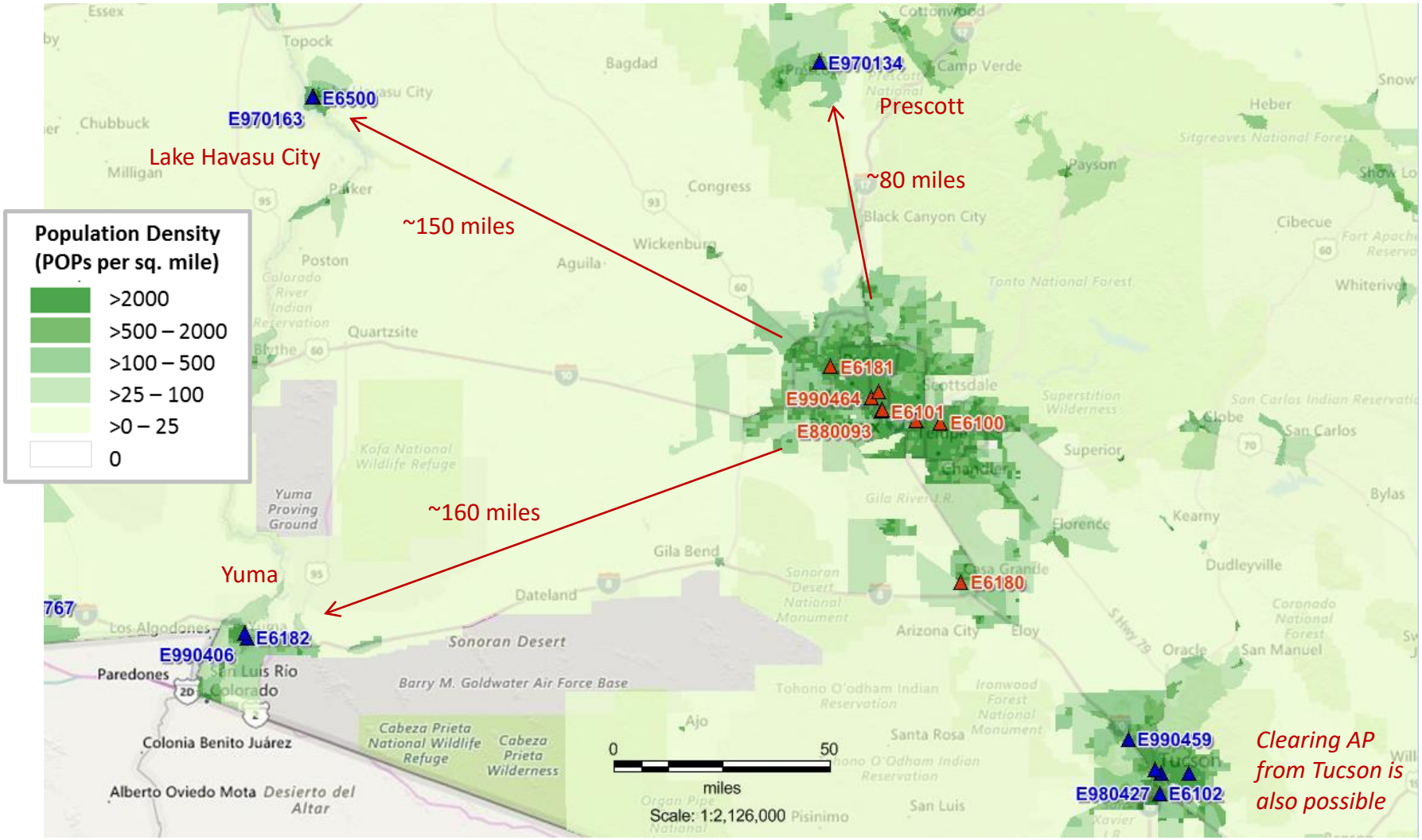
Phoenix C Band Earth Stations

Call_Sign	Licensee	Case	File_Num	Location	State	AMSL	Lat	Lon
E6100	Associated Press	1	SES-RWL-20030826-01180	MESA	AZ	376.4	33.4133	-111.8342
E6101	Associated Press	1	SES-RWL-20030826-01167	PHOENIX	AZ	332.1	33.4517	-112.0711
E6180	Associated Press	1	SES-RWL-20030916-01289	CASA GRANDE	AZ	425.2	32.8772	-111.7525
E6181	Associated Press	1	SES-RWL-20030916-01290	SUN CITY	AZ	349.6	33.6003	-112.2756
E880093	Associated Press	1	SES-RWL-20071127-01619	PHOENIX	AZ	331	33.4539	-112.0697
E980439	Associated Press	1	SES-RWL-20080903-01144	Tempe	AZ	355.1	33.4197	-111.9335
E990464	Associated Press	1	SES-RWL-20091029-01373	PHOENIX	AZ	339.2	33.4944	-112.1133
E990490	Associated Press	1	SES-RWL-20091029-01393	PHOENIX	AZ	348.7	33.5178	-112.0825
E040294	Cable One, Inc.	1	SES-LIC-20040702-00951	CHANDLER	AZ	352	33.3111	-111.9540
E3991	Cox	1	SES-RWL-20120112-00053	WICKENBURG	AZ	677	33.9650	-112.7525
E8014	Cox	1	SES-RWL-20041215-01841	PHOENIX	AZ	410	33.6456	-112.1156
E970204	Cox	1	SES-RWL-20070207-00200	CHANDLER	AZ	359.7	33.3042	-111.9128
E000528	Fox	1	SES-RWL-20100717-00930	PHOENIX	AZ	329.18	33.4486	-112.0804
E000529	Fox	1	SES-RWL-20100717-00931	PHOENIX	AZ	347.47	33.5180	-112.0799
E010254	Antenna Technology Communications, Inc.	2	SES-MOD-20140304-00124	CHANDLER	AZ	352	33.3111	-111.9533
E010255	Antenna Technology Communications, Inc.	2	SES-MOD-20140304-00123	CHANDLER	AZ	352	33.3111	-111.9533
E140033	Antenna Technology Communications, Inc.	2	SES-LIC-20140304-00122	Chandler	AZ	357.2	33.3111	-111.9532
E130055	CBS	2	SES-REG-20130318-00271	Phoenix	AZ	331.01	33.4579	-112.0744
E020233	EchoStar	2	SES-RWL-20170919-01033	GILBERT	AZ	381	33.3669	-111.8147
E060399	EchoStar	2	SES-LIC-20061031-01927	Gilbert	AZ	371.86	33.3668	-111.8137
E170093	EchoStar	2	SES-LIC-20170414-00403	Gilbert	AZ	381	33.3667	-111.8147
E970396	EchoStar	2	SES-RWL-20070921-01306	GILBERT	AZ	371.3	33.3668	-111.8142
E030162	Iridium Constellation LLC	2	SES-LIC-20030722-01016	Chandler	AZ	362.7	33.2663	-111.8815
E030112	KDMA CHANNEL 25, INC.	2	SES-REG-20030513-00643	PHOENIX	AZ	440.1	33.6955	-112.0947
E950195	KPHO Broadcasting Corporation	2	SES-MOD-20160104-00002	PHOENIX	AZ	348.9	33.5184	-112.0809
E060267	Maricopa County Community College District	2	SES-REG-20060717-01163	TEMPE	AZ	348.1	33.4124	-111.9737
E980342	Qwest Broadband Services, Inc.	2	SES-RWL-20080625-00845	TEMPE	AZ	364.2	33.3647	-111.9400
E040085	RCN	2	SES-LIC-20040213-00226	Phoenix	AZ	346.86	33.4461	-112.0000
E050221	Scripps	2	SES-REG-20050715-00927	PHOENIX	AZ	353.57	33.4545	-111.9846
E170123	Skyview Satellite Networks	2	SES-LIC-20170710-00745	Phoenix	AZ	438.91	33.6851	-112.0974
E170124	Skyview Satellite Networks	2	SES-LIC-20170710-00746	Scottsdale	AZ	441.96	33.6169	-111.9207
E130154	Trinity Broadcasting	2	SES-REG-20130813-00724	PHOENIX	AZ	350.65	33.4647	-112.0047
E6020	WESTERN BROADBAND, LLC	1 or 2	SES-RWL-20070305-00297	SUN LAKE	AZ	362.7	33.2181	-111.8769

Proposal

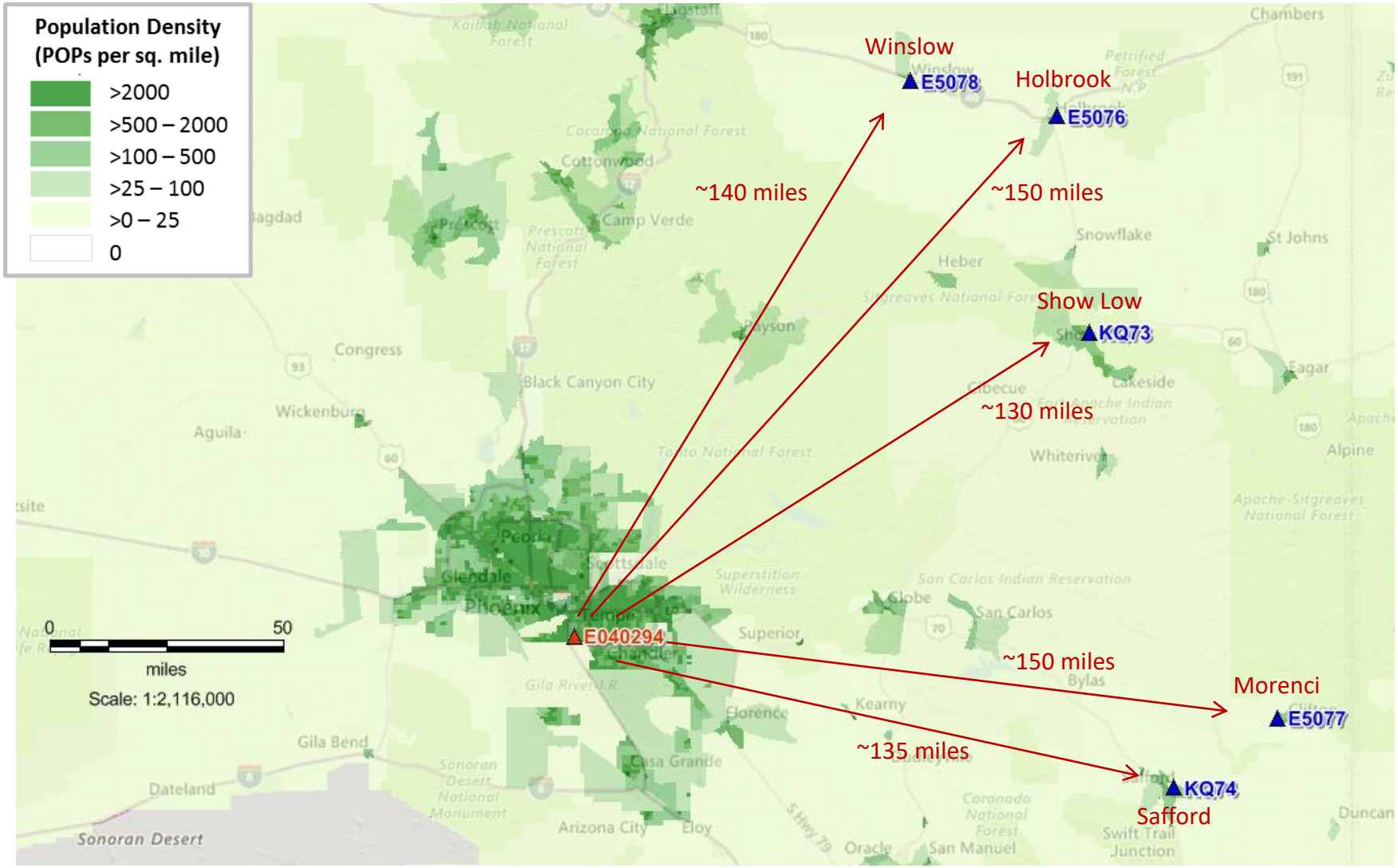
1. Some licensees operating earth stations that need to be relocated also operate earth stations outside the 60 kilometer buffer and in suitably remote areas
   - In these cases, we propose to decommission the licensee's earth station(s) within the buffer and replace the service with a fiber feed from one of the licensee's nearby, remote earth stations
2. Other licensees do not have this option
   - In these cases, we propose to build a C band antenna farm in a remote location and connect the licensees to their antenna(s) by fiber
   - The antenna farm could include mitigation techniques such as shielding to reduce the separation distance required

Case 1: Associated Press Earth Stations



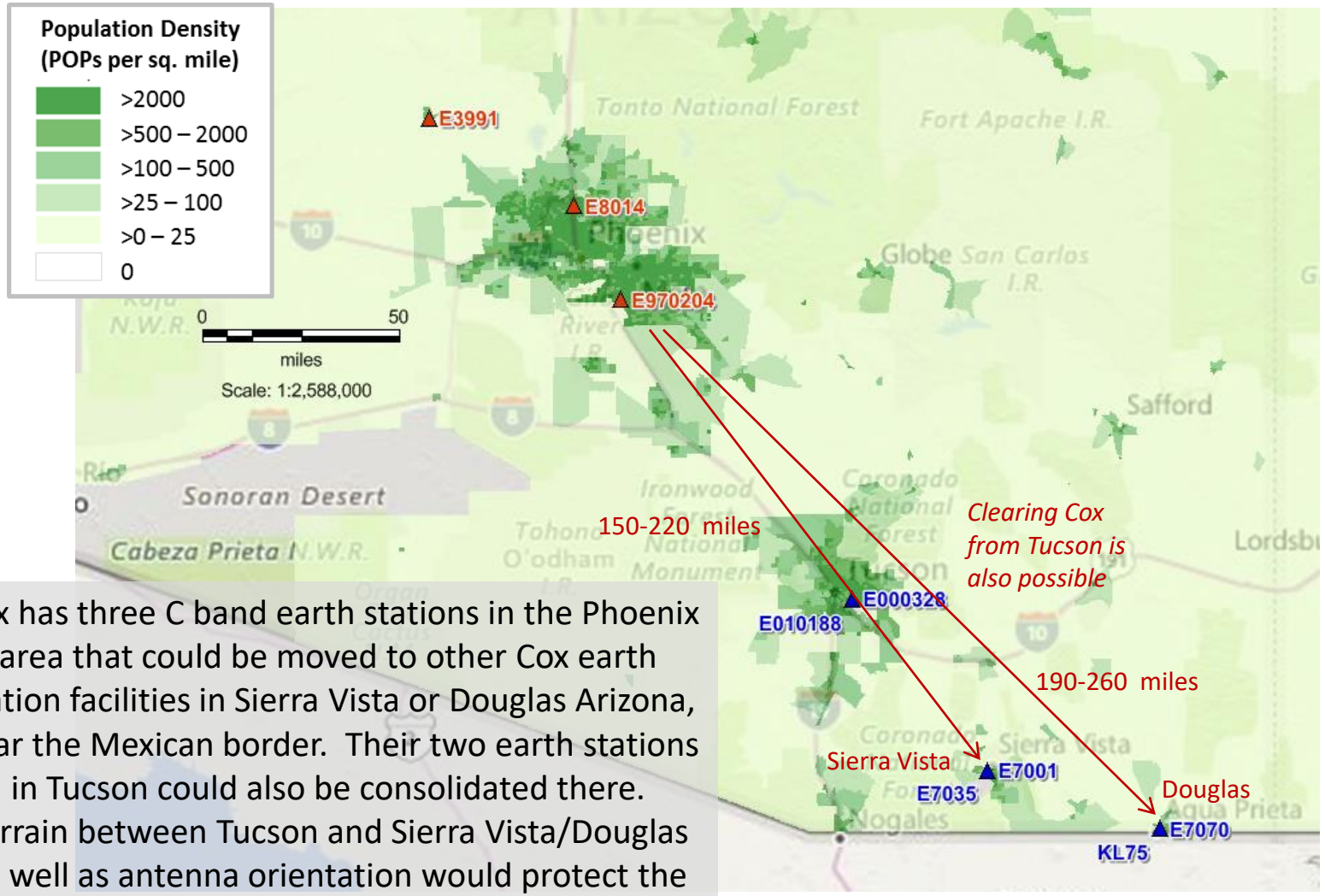
The satellite feeds to eight AP earth stations in Phoenix could be replaced by fiber feeds from existing satellite reception Yuma, Lake Havasu City, and/or Prescott, Arizona

Case 1: Cable One Earth Station



The satellite feeds to the Cable One earth station in Phoenix could be replaced by fiber feeds from existing Cable One earth stations in Winslow, Holbrook, Show Low, Morenci and/or Safford, Arizona

Case 1: Cox Earth Stations

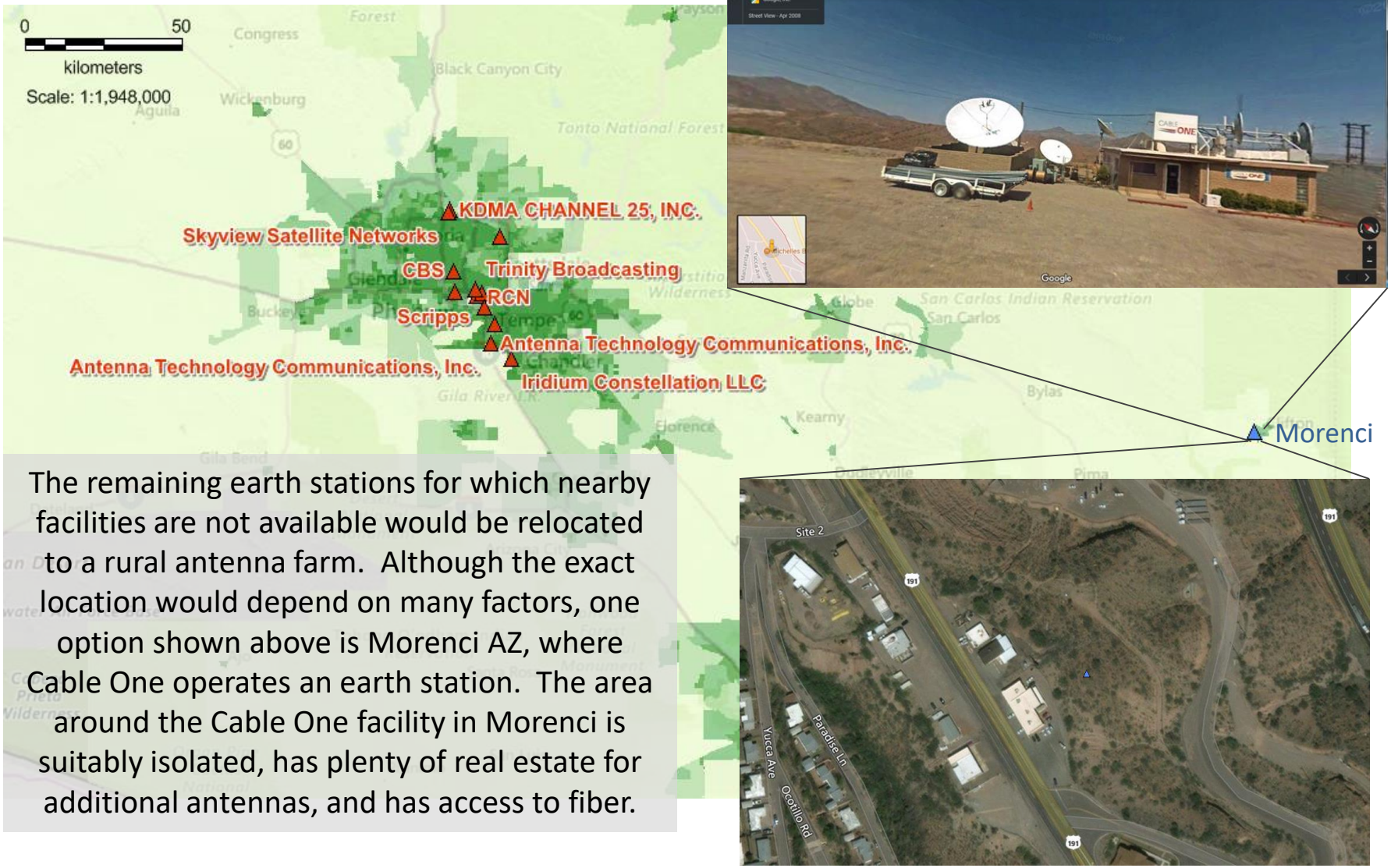


Cox has three C band earth stations in the Phoenix area that could be moved to other Cox earth station facilities in Sierra Vista or Douglas Arizona, near the Mexican border. Their two earth stations in Tucson could also be consolidated there. Terrain between Tucson and Sierra Vista/Douglas as well as antenna orientation would protect the earth stations from interference.

Case 1: Fox Earth Stations

Fox Broadcasting has two C band earth stations in the Phoenix area that could be decommissioned with services provided by Fox earth station facilities in Yuma Arizona.

Case 2: Rural Antenna Farm



The remaining earth stations for which nearby facilities are not available would be relocated to a rural antenna farm. Although the exact location would depend on many factors, one option shown above is Morenci AZ, where Cable One operates an earth station. The area around the Cable One facility in Morenci is suitably isolated, has plenty of real estate for additional antennas, and has access to fiber.

Mid-Band Assessment: Cost Factors Affecting Fiber as an Alternative to Satellite

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14 June 2018

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Summary of Analysis

- Replacement options for C-Band Satellite reception, in urban / metropolitan areas of US, with optional fiber based access links are identified

- Cost factors involved in the relocation of users are identified and evaluated for a major urban / suburban area (Chicago) in the US

- Conservative assumptions were used in modeling costs. These include:
  - Cost factors affecting fiber deployment
  - Availability of existing fiber links
  - Equipment replacement costs
  - Number of pre-existing and registered C-Band receivers (i.e. those registered as receive only stations in the IBFS database on or before July 18, 2018 FCC deadline) was assumed much larger than the Mid Band NOI estimate of 4,700 licensed or registered earth stations in the 3.7-4.2 GHz band

Results

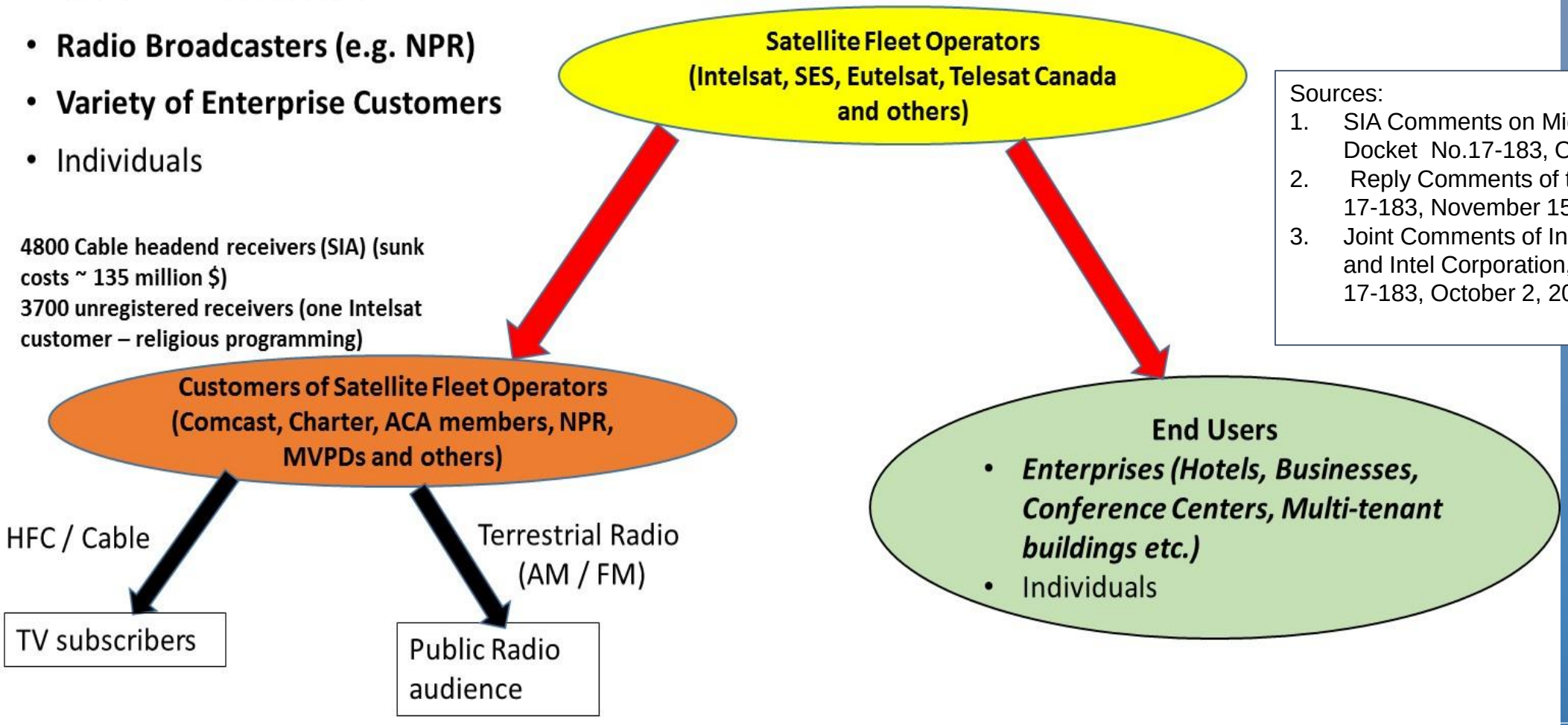
- Based on the modeling assumptions, a rough order of magnitude estimate for costs of relocating users in Chicago (urban/suburban areas) is developed
- Methodology can be applied to other metropolitan areas of the US
- Relocation methods do not impact the C-Band receivers operating in rural areas (MVPD operations serving smaller user communities) since they are not relocated and continue to receive satellite downlink transmissions
- Cost models could be refined with additional detailed input from stakeholders (satellite operators, cable operators and end users in specific markets)

Current Users of C-Band Downlink

Major Users

- **Cable TV Broadcasters**
- **Radio Broadcasters (e.g. NPR)**
- **Variety of Enterprise Customers**
- Individuals

- **4800 Cable headend receivers (SIA) (sunk costs ~ 135 million $)**
- **3700 unregistered receivers (one Intelsat customer – religious programming)**



Sources:

1. SIA Comments on Mid-Band NOI, Docket No.17-183, October 2, 2017
2. Reply Comments of the SIA, Docket No. 17-183, November 15, 2017
3. Joint Comments of Intelsat License LLC and Intel Corporation, GN Docket No. 17-183, October 2, 2017

C-Band Video Broadcast in US: By the Numbers

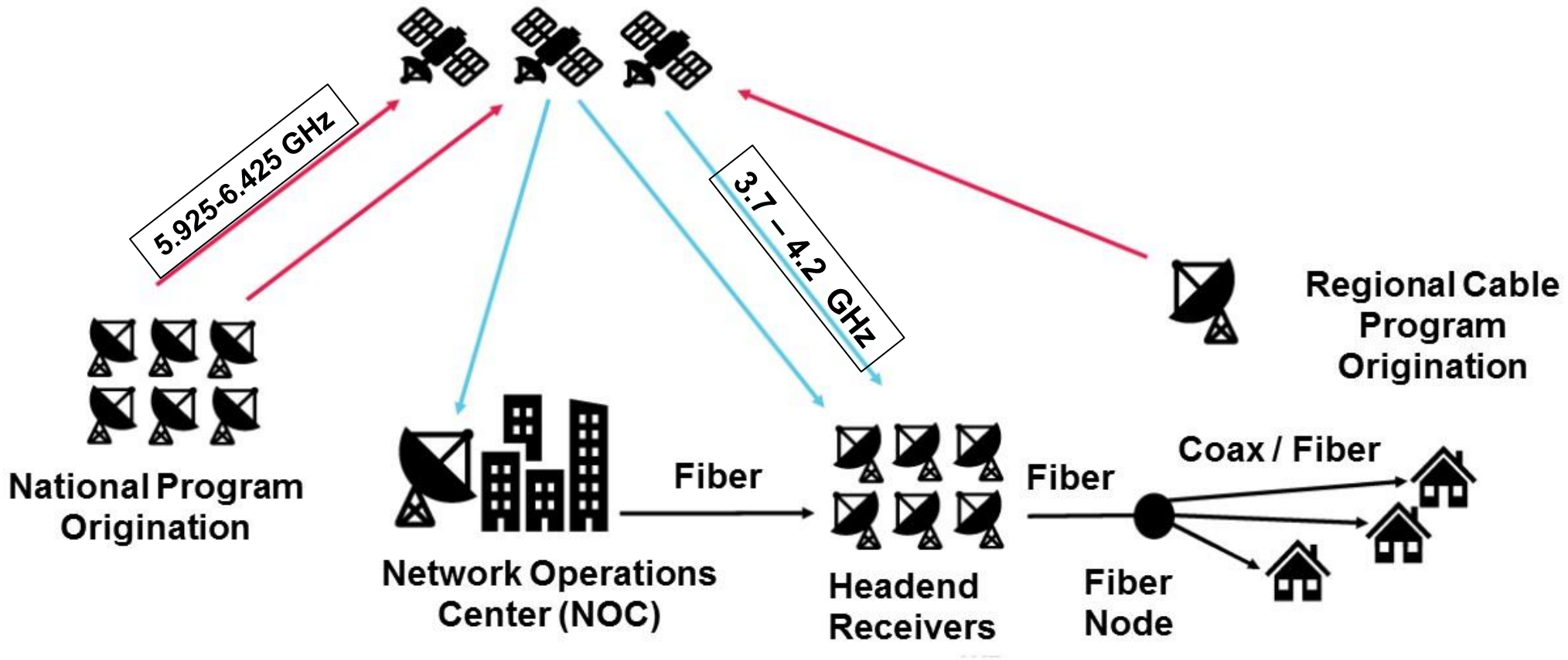
- Number of C-Band Satellites covering the US =24
- Total transponders = 308 (each using 36 MHz)
- Total feeds : 2012 (1781 video & 231 audio feeds)
- Video transmission at different resolutions: SD, HD & 4K
- MPEG encoding advances yield compression rates from 3:1 to 9:1 or higher
- Advanced modulation schemes deployed for spectral efficiency
- Each transponder can carry 20 SD channels or 8 HD channels or 4 UHD/4K channels (using HEVC compression superior to MPEG-4)
- Emergence of 4K and other high-bandwidth video technologies are driving demand for more C-Band capacity
- MVPD head ends (thousands) (including rural areas)
- > 1,000 broadcast affiliate stations, and over-the-top video distributors

- Cable operators receive and deliver to 51.9 million cable video customers using the 3.7-4.2 GHz band, relying on thousands of receive-only antennas, many of which are unregistered today.
- Comcast: 100's of C-Band receive ES, 80% of video programming using C-Band (148 transponders, 20 satellites, 86% transponders carry full-time feeds)
- Charter: Over 700 head-ends

Sources:

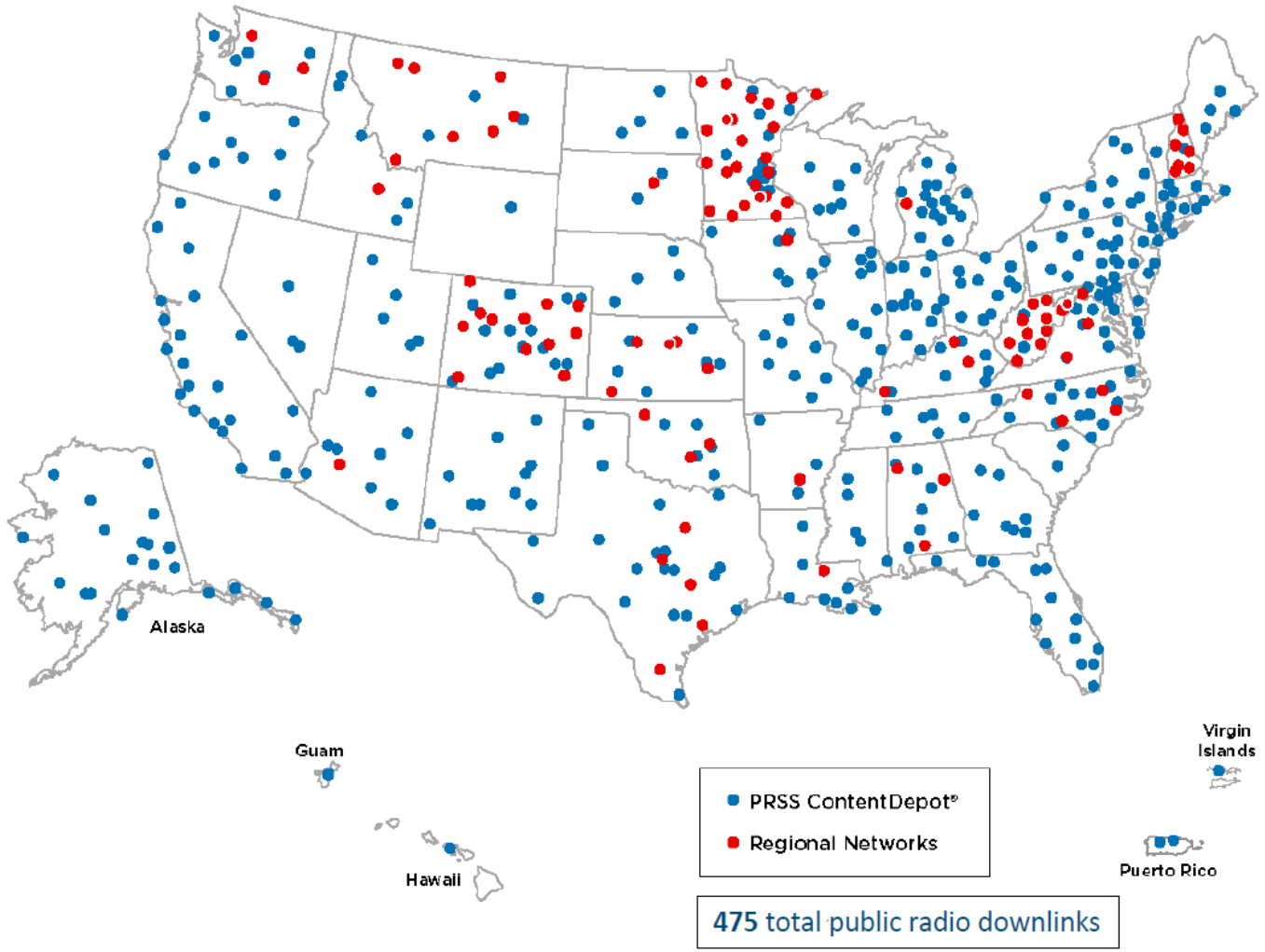
1. Comcast C-band Ex Parte McGrath, Dockets 17-183 18-122, May 10, 2018
2. Comcast-NBCU C-Band Ex Parte, Docket 18-122, June 8, 2018
3. Charter Mid-Band NOI Comments, Docket 17-183, October 3, 2017
4. Comments of the American Cable Association, Docket 17-183, October 2, 2017
5. https://www.lyngsat.com/america.html (information on satellite TV channels)

Cable Video Distribution System - Simplified View



Example: Incumbent Users (Radio broadcasters)

Public Radio C-Band Downlinks



475 total public radio downlinks

PRSS Leases A Satellite Transponder from Intelsat on C-Band

Downlink Frequencies

Galaxy 16/Transponder 1, C-Band:
Lower Frequency 3702.00 to
Upper Frequency 3738.00

Uplink Frequencies

Galaxy 16/Transponder 1, C-Band:
Lower Frequency 5927.00 to
Upper Frequency 5963.00

Getting Programs to Stations

VIA SATELLITE

LIVE & FILE PROGRAMS

VIA INTERNET

FILE PROGRAMS ONLY

Source: NPR ex-parte May 3, 2018 GN Docket Nos. 17-183, 18-122

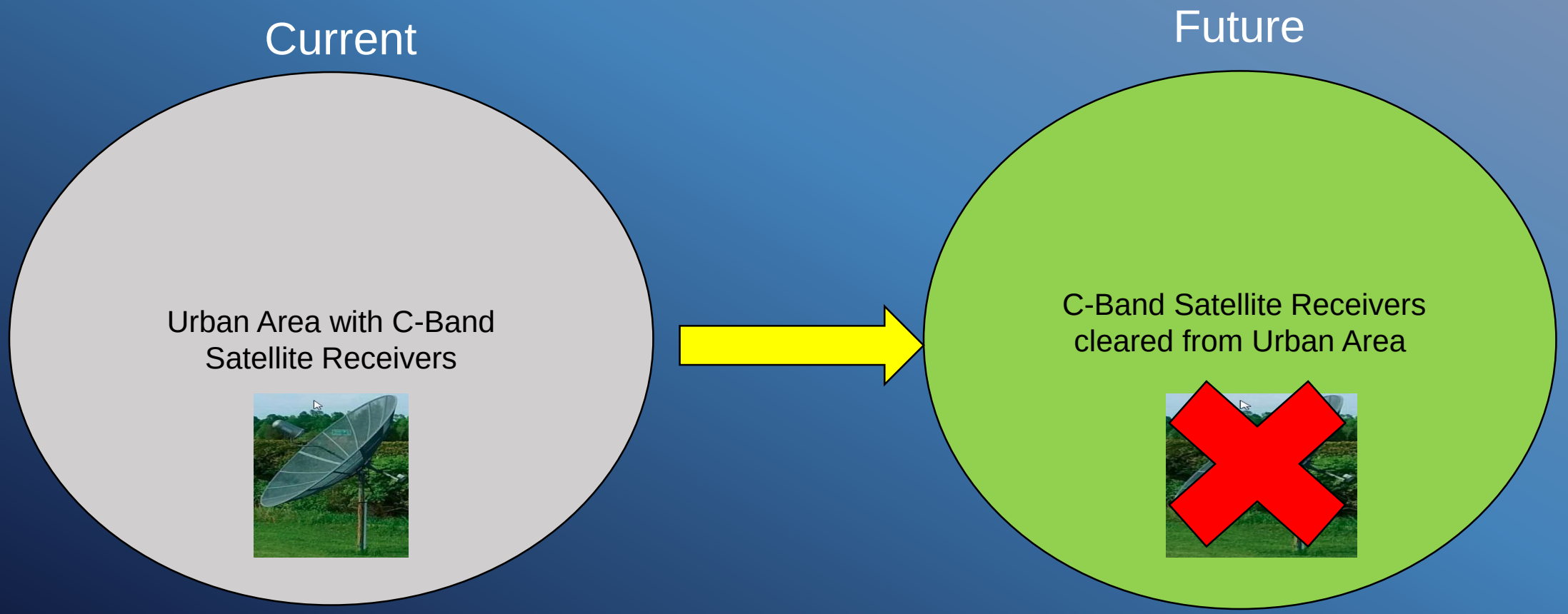
An Estimate of C-Band Receivers in Use

- Broadcast TV and Radio's infrastructure relies on satellite distribution to deliver content to and among its affiliate and owned and operated stations
- Content includes: News, talk, sports, entertainment and religious programming
- Satellite delivers programming to nearly every one of the more than 15,499 radio stations and 1,765 UHF and VHF television stations nationwide
- According to one estimate by LinkUp communications, there are over 27,000 C-band downlink locations nationally. Basis for estimate is use of C-Band downlinks in Panama City (Bay County), FL – population of 183,563 using 15 C-Band downlinks (i.e. 1 per 12,000 people). Extrapolation leads to nationwide estimate of 27000 receivers)
- Our models conservatively assumed the presence of 27,000 receivers (~575% the FCC NOI estimate of 4700 receivers)

Source: Ex-parte by LinkUp Communications Corporation, Society of Broadcast Engineers, Intelsat Corporation, SES Americom Inc., Docket Nos. 17-183, 18-122, May 24, 2018

Relocation of Satellite Users

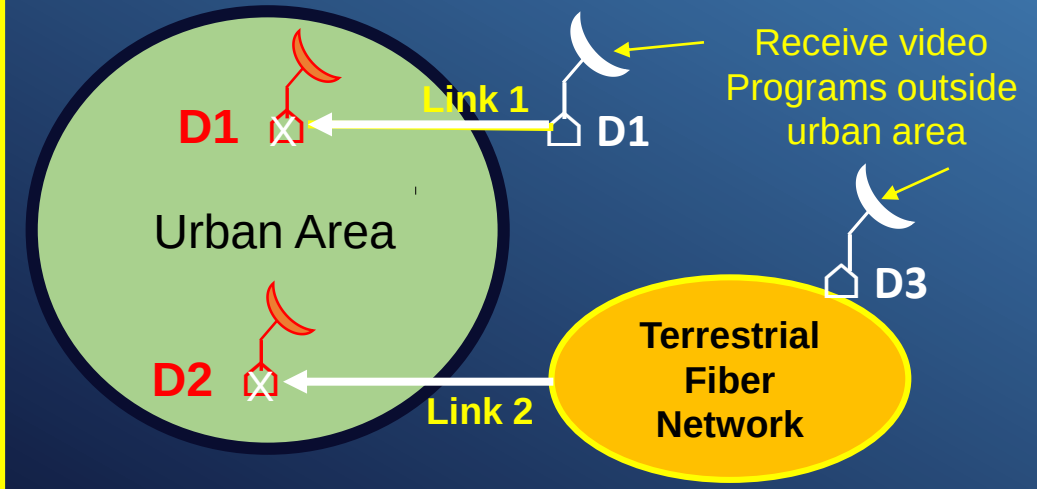
- Different classes of satellite users need to be cleared and/or relocated from C-Band.



Replacement options for C-Band satellite receivers in urban areas

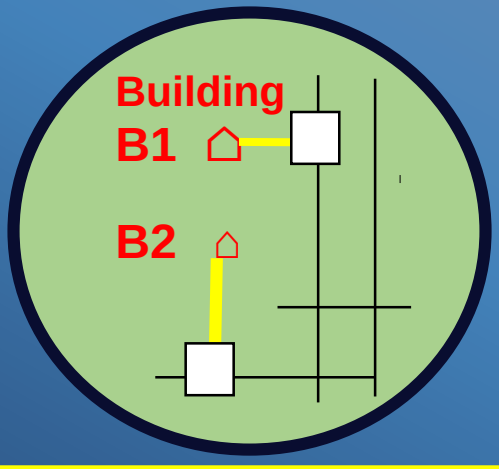
Option 1 (for Cable operators)

1. Relocate the receivers (Di's) to new locations outside urban area or connect to existing terrestrial fiber network
2. Provide fiber connectivity between the old and new locations
3. Local distribution networks are not changed (HFC networks)
4. End users keep same CPE equipment(s)



Option 2 (for enterprise/residential subscribers)

1. Replace the satellite receivers of existing, registered C-Band users by providing alternate high-speed fiber (Gbps+) links & fiber termination/ receiver
2. Abandon use of satellite dishes and associated receivers
3. Connectivity is provided to the nearest fiber access network in the urban area
4. Local distribution network inside the building is not changed



Relocation of Satellite Users

- Different classes of satellite users need to be cleared and/or relocated from C-Band.

Option 1: Relocation of Cable Broadcasters' Headend Receivers

- Relocate satellite head-ends from urban area to a location in a non-urban area.
  - Provide fiber connectivity to/from new satellite receiver location (~ 20 miles new fiber (see note below))
  - Extend the HFC network but no changes to the equipment of end users
  - Number of cable head-ends (total nationwide ~ 4800)
  - Expected number of cable head-ends in urban area – few hundreds or less
- Cable subscribers are not affected. No subscriber equipment changes are needed.

Note: A very conservative estimate of length of new fiber is used for connecting old and new satellite receiver locations. In urban / suburban markets, in addition to fiber network providers, there is a rich installed base of fiber backhaul / distribution networks used by wireless service providers and cable companies. These can be leveraged to lower the cost of new fiber installation.

Relocation of Satellite Users

Option 2: Relocation of C-Band Receivers from an Urban Area with Fiber Access

- Provide alternate access link to satellite subscriber (eliminates satellite link) – optical fiber
  - Provide fiber connectivity to the customer premises using FTTH (or equivalent access speed of 1 Gbps) (high probability in urban area, > 90 % in urban Chicago)

or

  - Seek new connectivity using “nearest” fiber access provider in the area
    - Cost of providing fiber access will depend on:
      - Specific location of existing satellite receiver
      - Proximity to get connected to an existing fiber network”
      - Variety of other factors (detailed next)

Factors Affecting Fiber Optic Installation Costs

1. Proximity of customer premises to the nearest active fiber line is a major factor.
   Does the fiber network run through or near the customer premises?

2. Existence of conduit in the customer premises
   - Take advantage of an existing conduit to lower the cost of adding new capacity to the customer premises
   - Use of existing conduit requires sufficient space to install fiber - substantially simpler & cheaper
   - Physical placement and route of fiber cable will have a major impact on the costs of its installation (winding paths more challenging than straight cables)

3. Physical obstacles in the way to the customer premises
   - The nature of the physical terrain that the fiber needs to traverse to reach the customer premise – a significant factor
   - In urban / suburban areas, crossing a state highway or major road to bring the nearest fiber to the customer premises will significantly impact the overall costs
   - Obstacles such as historic buildings/landmarks near the customer premises could potentially impact the costs of fiber installation, depending on the route fiber needs to take to the customer premises

Factors Affecting Fiber Optic Installation Costs (contd.)

4. Availability of space in the telco closets

- When the fiber is brought to a customer premises, if a telecommunications room with the necessary space for installation is already available, it can lower installation costs

5. Availability of sufficient power for fiber technology

- Availability of sufficient power for fiber accessible from telecommunications room and/or an emergency generator for backup purposes
- Save costs of introducing additional power capabilities

6. How many different paths to the customer premises can the fiber cable take?

- Fiber can be brought into a customer premise through two separate entry points. A primary fiber connection and a secondary fiber connection to mitigate potential outages if the primary fiber circuit is cut. While this is a rare occurrence, installing through two entrance points removes risk and improves reliability. This higher cost option may be needed for enterprises and/or business users, that may use C-Band receivers.

Cost of Establishing Fiber Connectivity

Cost of connecting a customer premises to the nearest fiber transit point of a provider depends on following factors.

- Distance (x miles)
- New construction or Existing fiber infrastructure (typical of urban / metro areas):
  - Terrain that the fiber would have to traverse
    - Bury the fiber underground (per mile: $ 45,000-50,000 for construction labor + $ 9,250 material)
    - Overground (stringing across poles)
      - Per mile: $ 9,000 for labor + $ 3,500 material plus
      - Pole attachment costs – “make-ready” costs + pole attachment rental costs (recurring)
    - Cost of leasing fiber from transit provider (1Gbps – $ 3,000 / month)
- Additional cost if backup connectivity to transit provider is needed for reliability

Note: Cost factors are based on figures noted in the following:
Comments of the American Cable Association, GN Docket 17-183, October 2, 2017.

Scope of Relocation Effort: Top 30 Metropolitan Areas

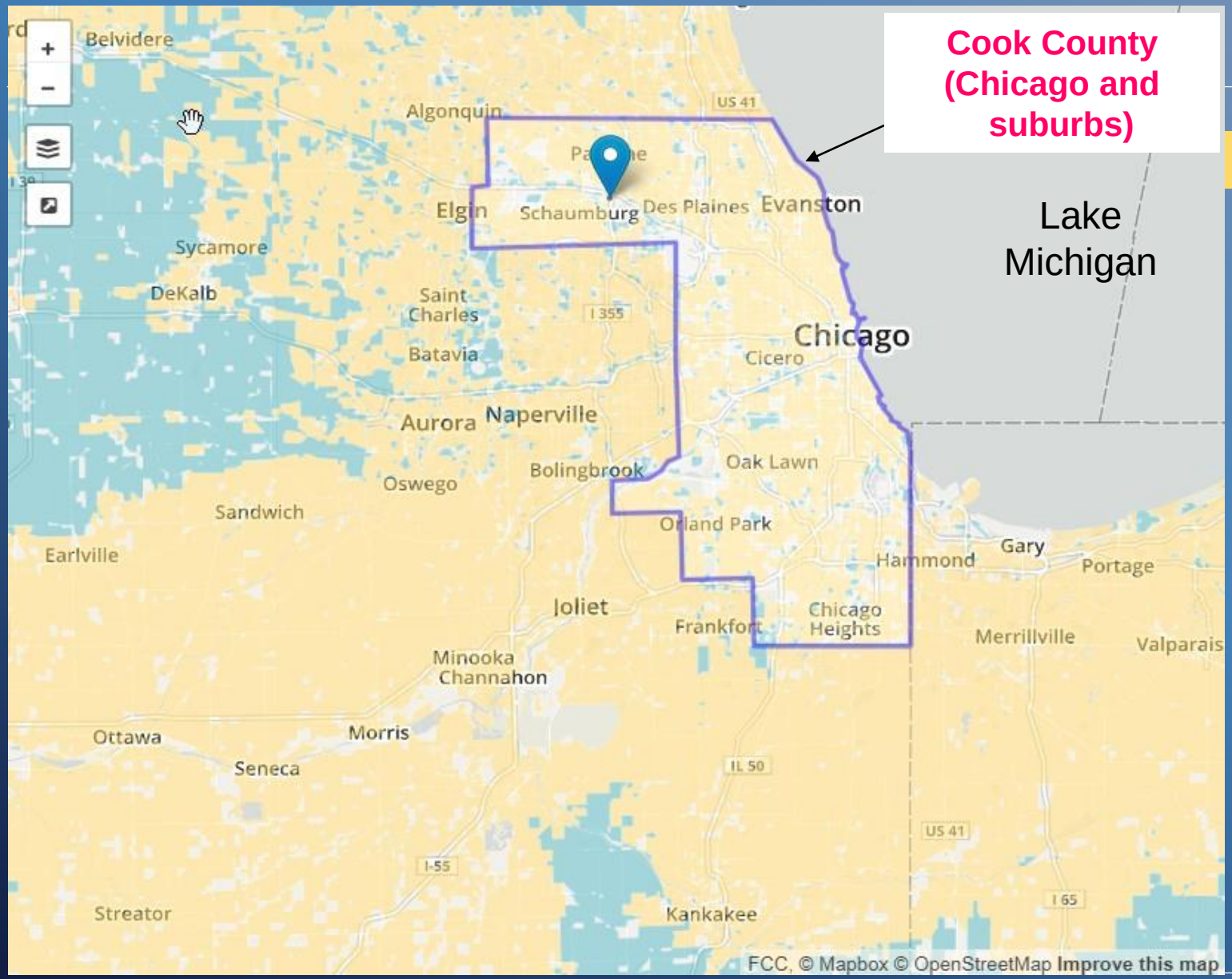
(urban and suburban areas with at least 2 million population)

Rank	Metropolitan statistical area	2017 Estimate
1	New York-Newark-Jersey City, NY-NJ-PA MSA	20,320,876
2	Los Angeles-Long Beach-Anaheim, CA MSA	13,353,907
3	Chicago-Naperville-Elgin, IL-IN-WI MSA (*)	9,533,040
4	Dallas-Fort Worth-Arlington, TX MSA	7,399,662
5	Houston-The Woodlands-Sugar Land, TX MSA	6,892,427
6	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	6,216,589
7	Miami-Fort Lauderdale-West Palm Beach, FL MSA	6,158,824
8	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	6,096,120
9	Atlanta-Sandy Springs-Roswell, GA MSA	5,884,736
10	Boston-Cambridge-Newton, MA-NH MSA	4,836,531
11	Phoenix-Mesa-Scottsdale, AZ MSA	4,737,270
12	San Francisco-Oakland-Hayward, CA MSA	4,727,357
13	Riverside-San Bernardino-Ontario, CA MSA	4,580,670
14	Detroit-Warren-Dearborn, MI MSA	4,313,002
15	Seattle-Tacoma-Bellevue, WA MSA	3,867,046

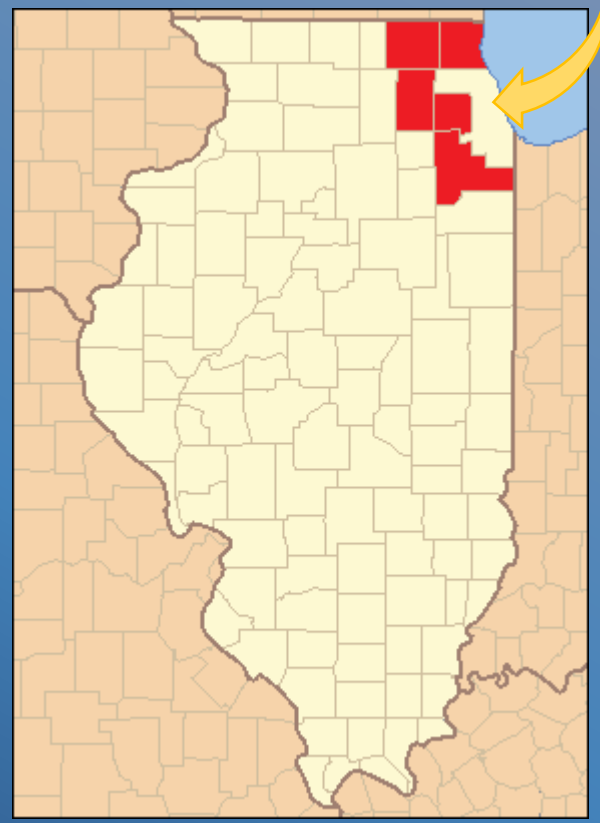
Rank	Metropolitan statistical area	2017 Estimate
16	Minneapolis-St. Paul-Bloomington, MN-WI MSA	3,600,618
17	San Diego-Carlsbad, CA MSA	3,337,685
18	Tampa-St. Petersburg-Clearwater, FL MSA	3,091,399
19	Denver-Aurora-Lakewood, CO MSA	2,888,227
20	Baltimore-Columbia-Towson, MD MSA	2,808,175
21	St. Louis, MO-IL MSA	2,807,338
22	Charlotte-Concord-Gastonia, NC-SC MSA	2,525,305
23	Orlando-Kissimmee-Sanford, FL MSA	2,509,831
24	San Antonio-New Braunfels, TX MSA	2,473,974
25	Portland-Vancouver-Hillsboro, OR-WA MSA	2,453,168
26	Pittsburgh, PA MSA	2,333,367
27	Sacramento–Roseville–Arden-Arcade, CA MSA	2,324,884
28	Las Vegas-Henderson-Paradise, NV MSA	2,204,079
29	Cincinnati, OH-KY-IN MSA	2,179,082
30	Kansas City, MO-KS MSA	2,128,912

https://en.wikipedia.org/wiki/List_of_metropolitan_statistical_areas

This analysis is focused on Chicago and surrounding areas in Cook County (a subset of the 3rd ranked MSA in above table)



Cook County, IL
Total Population: 5,194,675



(Cook, DuPage, Kane, Lake, McHenry, and Will)

Chicago Analysis

- Providers of speeds (up to 1 Gbps) are present in a large fraction of the urban Chicago area. Number of carriers providing termination at the customer premises varied from 1 to 3 in all the zip code areas that we sampled at random.

- An incumbent user with C-Band satellite receiver located in any of these zip code areas can avail of the Gbps service from one of the commercial providers serving the area.

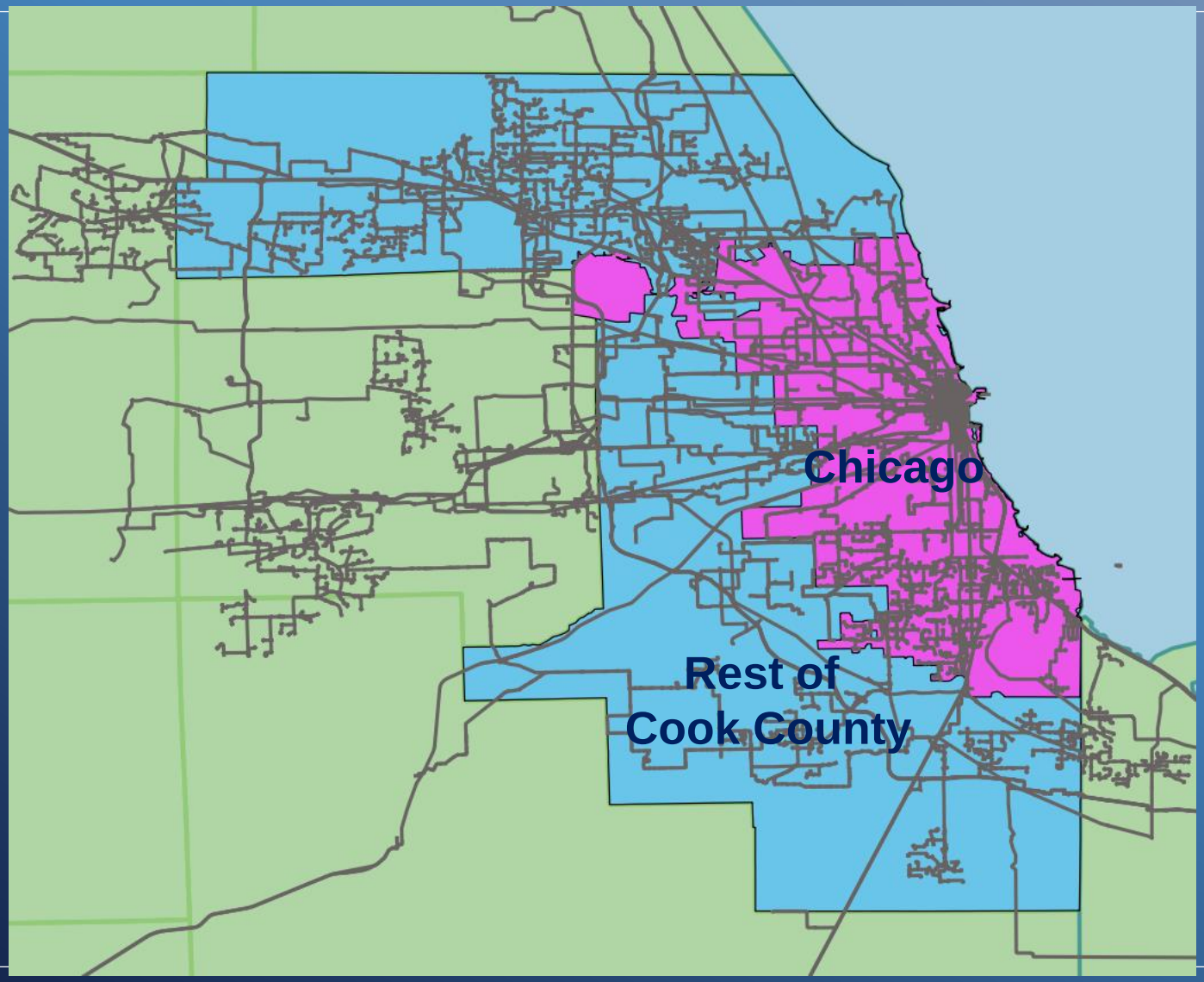
- An incumbent user with a C-Band satellite receiver but no Gbps service available at his/her premise (using fiber and/or cable distribution) has the option to securing a fiber connectivity at a cost.

Candidate Fiber Providers in Chicago

Company	Maps	Lit/Dark	Comments
Crown Castle	Chicago	Both	
Level 3 Communications	Chicago	Both	Google Maps interface, zoom in
Mirovia Networks	Chicago	Lit	
Uniti Fiber	Chicago	Both	
US Signal	Chicago Area, Rockford	Both	Flash map: click on Chicago for detailed map.
Windstream	Chicago Area	Both	
WOW! Businesss	Chicago Area	Lit	KMZ
Zayo	Chicago Area	Both	
Atlantic Metro		Lit	
Cogent		Lit	On-net buildings tool
XO		Both	

(Source: https://www.telecomramblings.com/metro-fiber-maps/chicago/)

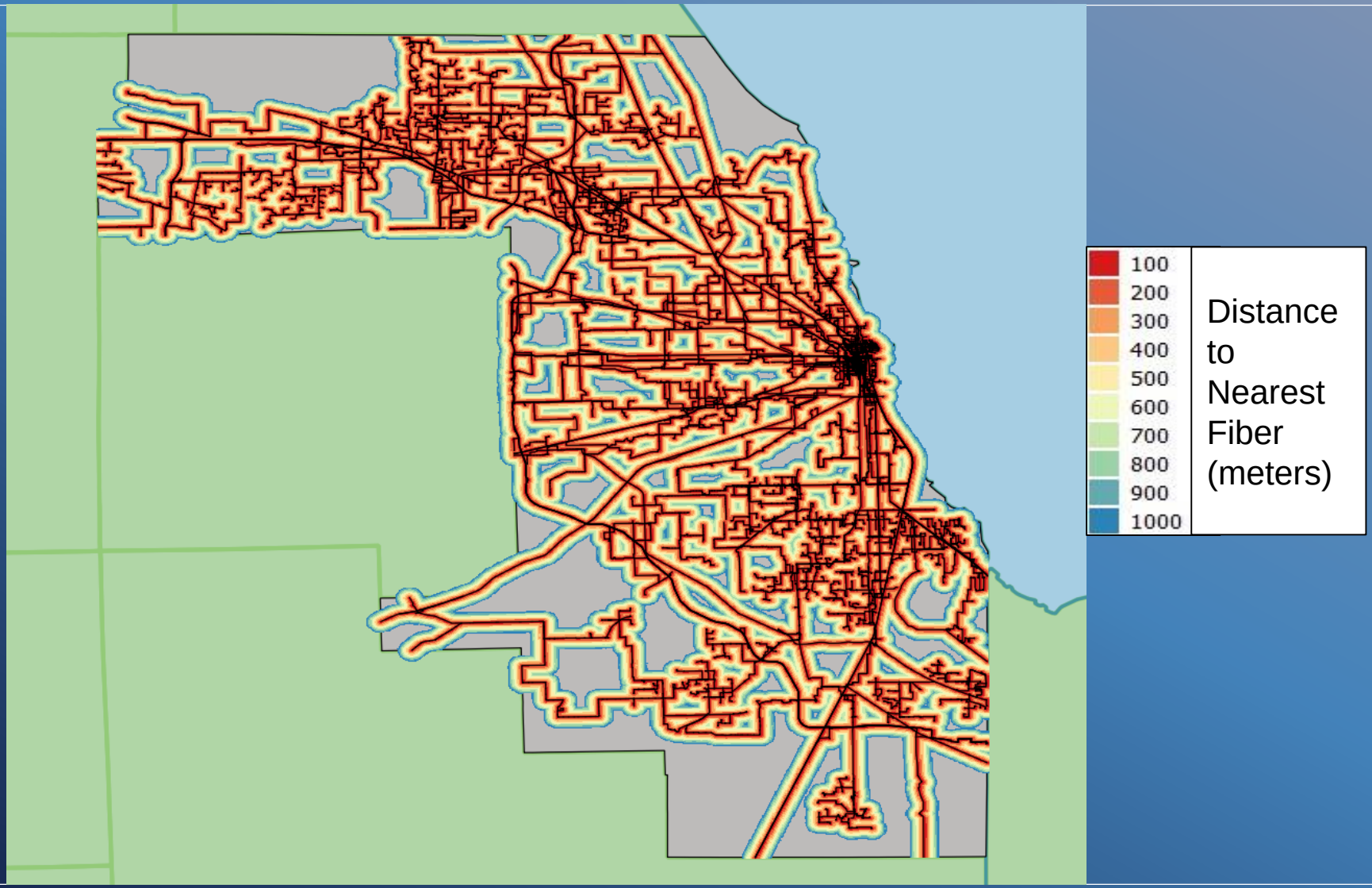
4 Fiber Networks Combined



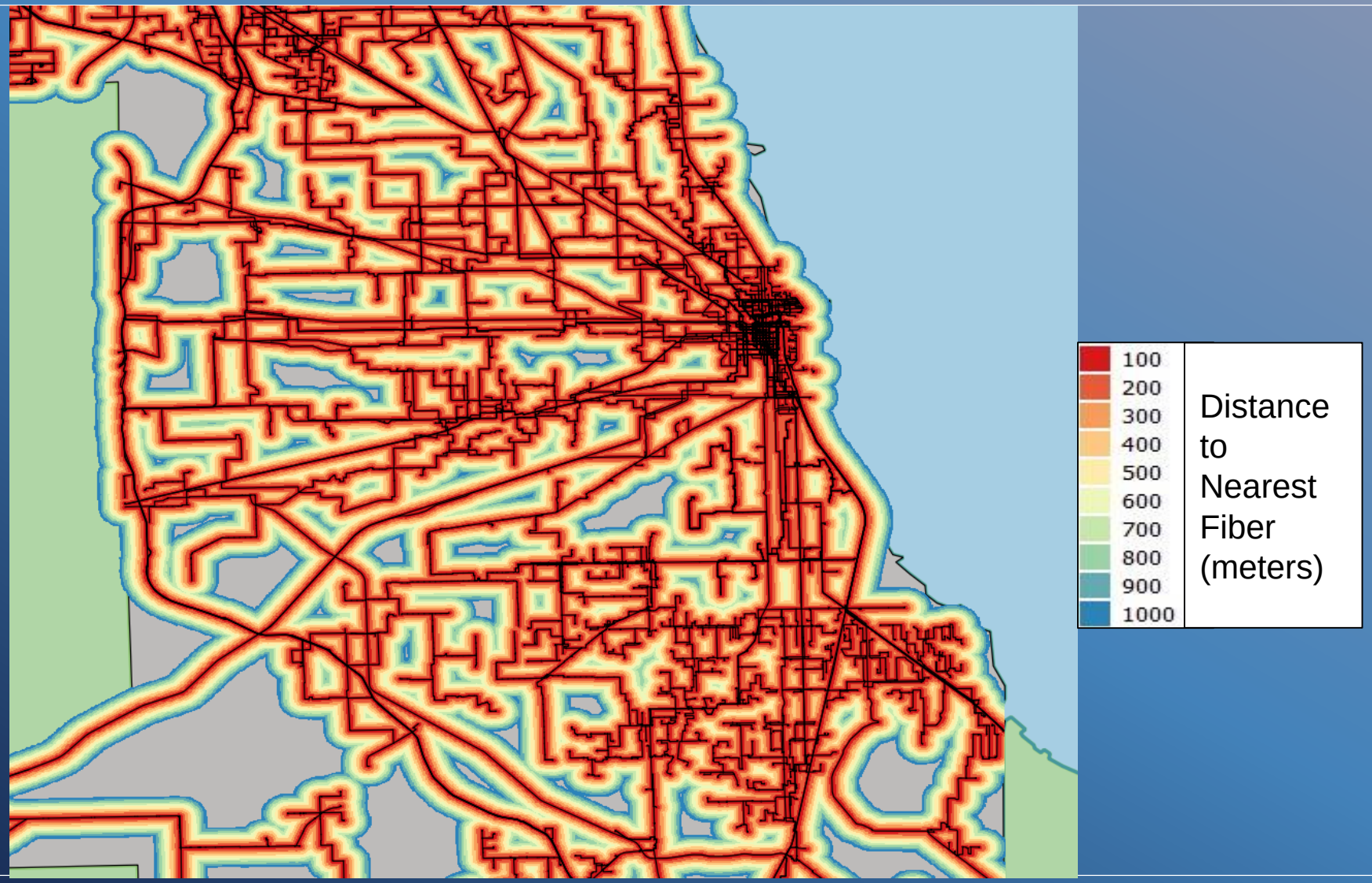
Fiber Providers included:
1. Crown Castle Fiber
2. Windstream
3. Wide Open West
4. Zayo

Note: Map could be enriched further if fiber deployment data of additional providers becomes available

Heat Map of Proximity to a Fiber Provider



Close up view of Proximity Heat Map



ISP's in Chicago Area: An estimate of coverage and speed

Summary of Internet Providers in Chicago	https://broadbandnow.com/Illinois/Chicago			
	Provider	Type	Coverage	Speed
1	AT&T Internet	DSL and Fiber	99.8%+	1,000 Mbps
2	XFINITY from Comcast	Cable	96.2%+	987 Mbps
3	RCN	Cable	82.1%+	1,000 Mbps
4	Comcast Business	Cable	84.2%+	987 Mbps
5	AT&T	DSL and Fiber	100%	1,000 Mbps
6	Level 3 Communications	Fiber	90.0%+	1,000 Mbps
7	Crown Castle Fiber	Fiber	83.3%+	1,000 Mbps
8	RCN Business	Cable and Fiber	49.1%+	1,000 Mbps
9	Verizon Business	Copper	44.1%+	1,000 Mbps
10	Cogent Communications	Fiber	31.7%+	1,000 Mbps
11	Zayo	Fiber	19.1%+	400 Mbps
12	Towerstream	Fixed Wireless	7.8%+	1,000 Mbps

1. The above information is one source of information on ISP's serving Chicago / Cook County. However, we rely on our own analysis to estimate availability of fiber connectivity and cost estimation.
2. On a nationwide basis, the NCTA has noted availability of Cable's DOCSIS 3.0 high-speed internet networks to more than 85% of U.S. households. https://www.ncta.com/chart/availability-of-docsis-30-high-speed-internet-service. The cable industry is now deploying even faster (10 Gbps service) based on DOCSIS 3.1. It is reasonable to expect about 90% of U.S. households can get at least 1 Gbps service.

Approach to Estimating Cost for providing fiber to incumbent users of C-Band Receivers

For each urban area, perform the following steps

1. Determine number of fiber providers
2. Determine details of individual providers' fiber infrastructure
3. Combine the various providers infrastructure maps
4. Generate fiber proximity heat maps indicating areas within specified distance ranges from available providers
5. Pick a specified number of locations (in an urban area) – random or specified
6. For each location X, determine the "distance" to a combined fiber network
7. Determine the cost of providing fiber access to location X
8. Compute the average cost of providing fiber access

Cost Model for Option 1

(Conservative cost estimates for relocating cable head ends of cable operators)

Connectivity Costs		
Link 1	**Average length of fiber connectivity (miles) from existing to new location of cable head ends**	**20**
	Cost of fiber connectivity ($ per foot)	**$ 20**
	Cost of connecting old & new headend locations with fiber	**$ 2,112,000**
Link 2	**Average length of fiber connectivity (miles) to an existing terrestrial fiber network used for video distribution**	**2**
	Cost of connecting to existing terrestrial fiber network	**$ 211,200**
	Probability Link 1 is used (%)	**50**
	Probability Link 2 is used (%)	**50**
	Expected fiber costs for relocating cable head ends	**$ 1,161,600**
Headend Equipment Replacement Costs	**Probability of satellite headend being relocated**	**0.5**
	Estimated number of satellite head ends in Cook County	**71**
	Average cost of satellite headend ($)	**$ 50,000**
	Expected replacement cost of satellite head ends ($)	**$ 1,775,000**

Cost Model for Option 2
(Conservative cost estimates for replacing C-Band receivers)

Cost Model (urban Chicago) All costs are in U.S. Dollars	
US Population (million)	325
Chicago population (million)	2.7
Total # C-Band Receivers (worst case estimate)	27000
Percentage of population in urban Chicago	0.83
# of Satellite C-Band Receivers	224
Average # of city blocks to fiber access	1
Length of Chicago city block = 660 x 330 feet	495
Average length of fiber (feet)	495
Cost per foot of fiber wire ($ per foot) (see Note 1 below)	$ 110
Probability 1 Gbps available (%)	90
Expected Cost of wiring with fiber	$ 5,445
Expected Cost of replacing satellite w/ fiber for all existing C-band dishes in Chicago	**$ 1,219,680**

Cost Model (Cook County - Chicago and suburbs) All costs are in U.S. Dollars	
US Population (million)	325
Cook County (including Chicago) population (million)	5.194
Total # C-Band Receivers (worst case estimate)	27000
Percentage of population in Cook County (including Chicago)	1.598
# of Satellite C-Band Receivers	431
Average # of county blocks to fiber access	3
Length of a county block = 660 feet	660
Average length of fiber (feet)	1980
Cost per foot of fiber wire ($ per foot)	$ 20
Probability 1 Gbps available (%) (see Note 2 below)	70
Expected Cost of wiring with fiber	$ 11,880
Expected Cost of replacing satellite w/ fiber for all existing C-band dishes in Cook County	**$ 5,120,280**

Note 1: Cost per foot of fiber is ~ $ 11 per foot (according to American Cable Association filing (cited earlier). We make a conservative assumption the cost per foot in urban Chicago is 10 times the ACA estimate.

Note 2: We make conservative assumption of 70% availability of 1 Gbps service in Cook County (compared to estimate of > 85% nationwide availability of cable DOCSIS 3.0 + offering 1 Gbps or greater service)

Cost Model Summary

Chicago and surroundings (Cook County)

Option 1: Relocating cable head ends of cable operators (from Cook County)

- Expected fiber costs for relocating cable head ends = $ 1,161,600
- Expected replacement cost of satellite head ends ($) = $ 1,775,000
- Total estimated cost to cable operators = $ 2,936,600

Option 2: Replacing C-Band receivers of individuals / enterprise customers

- Expected Cost of replacing satellite w/ fiber for all existing dishes in Chicago = $ 1,219,680
- Expected Cost of replacing satellite w/ fiber for all existing dishes in Cook County = $ 5,120,280

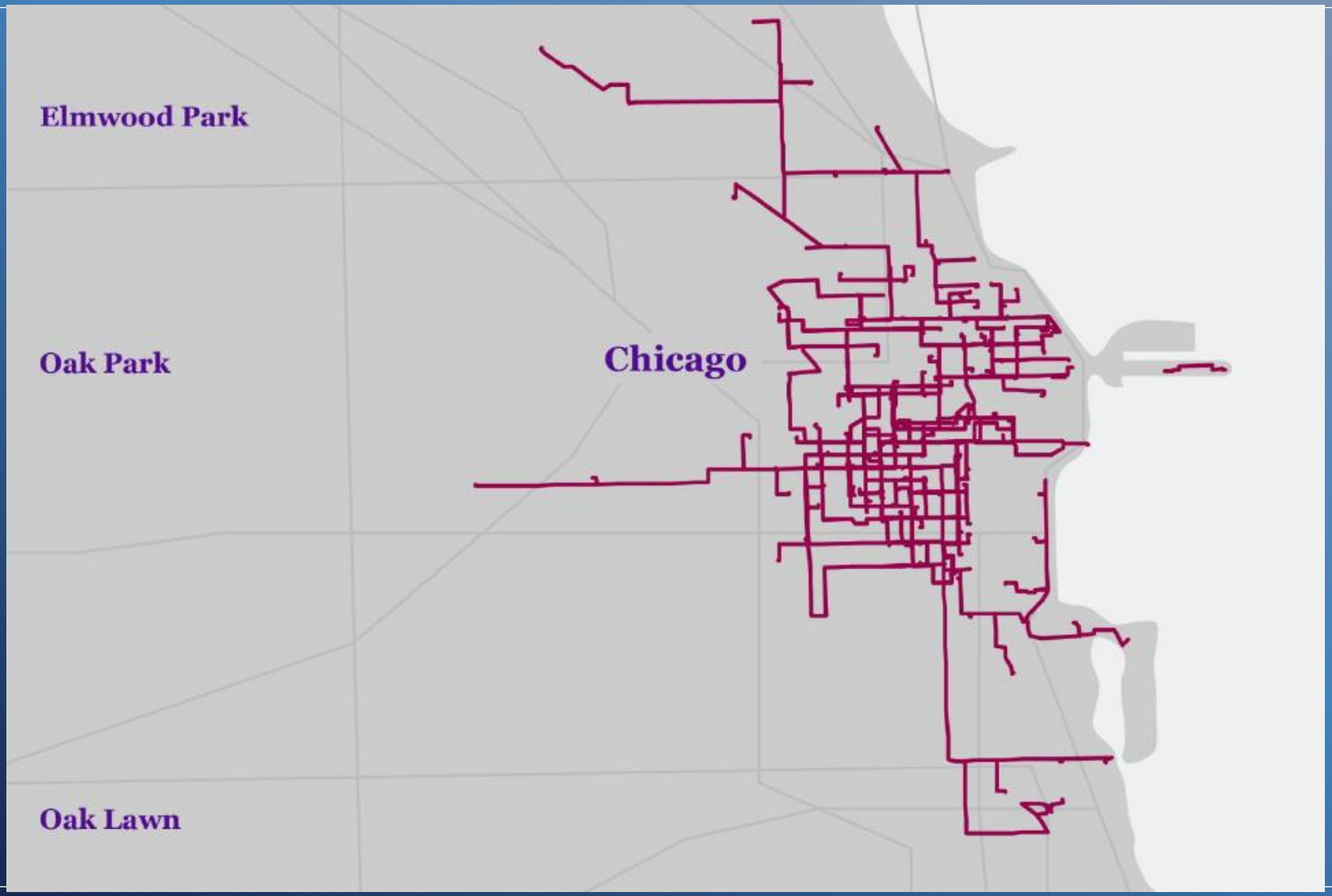
Conclusions

- As a result of our analysis, replacement of satellite by fiber should be feasible based on the availability of fiber and equipment replacement costs
- Results show the economic viability of clearing C-Band spectrum from urban / suburban areas in Chicago and surroundings market
- Economic analysis for other urban or metropolitan areas will need a case-by-case review; It is reasonable to expect the viability of clearing C-Band spectrum will hold in other major markets as well.
- Rural markets are not significantly affected by the relocation methods. They may continue use of C-Band spectrum with minimal or no impact to the existing C-Band customers / users.
- Improvement of satellite resource utilization through optimized assignment of satellite transponder capacity as a function of time, space and frequency has potential to clear greater amount of spectrum for 5G terrestrial use.

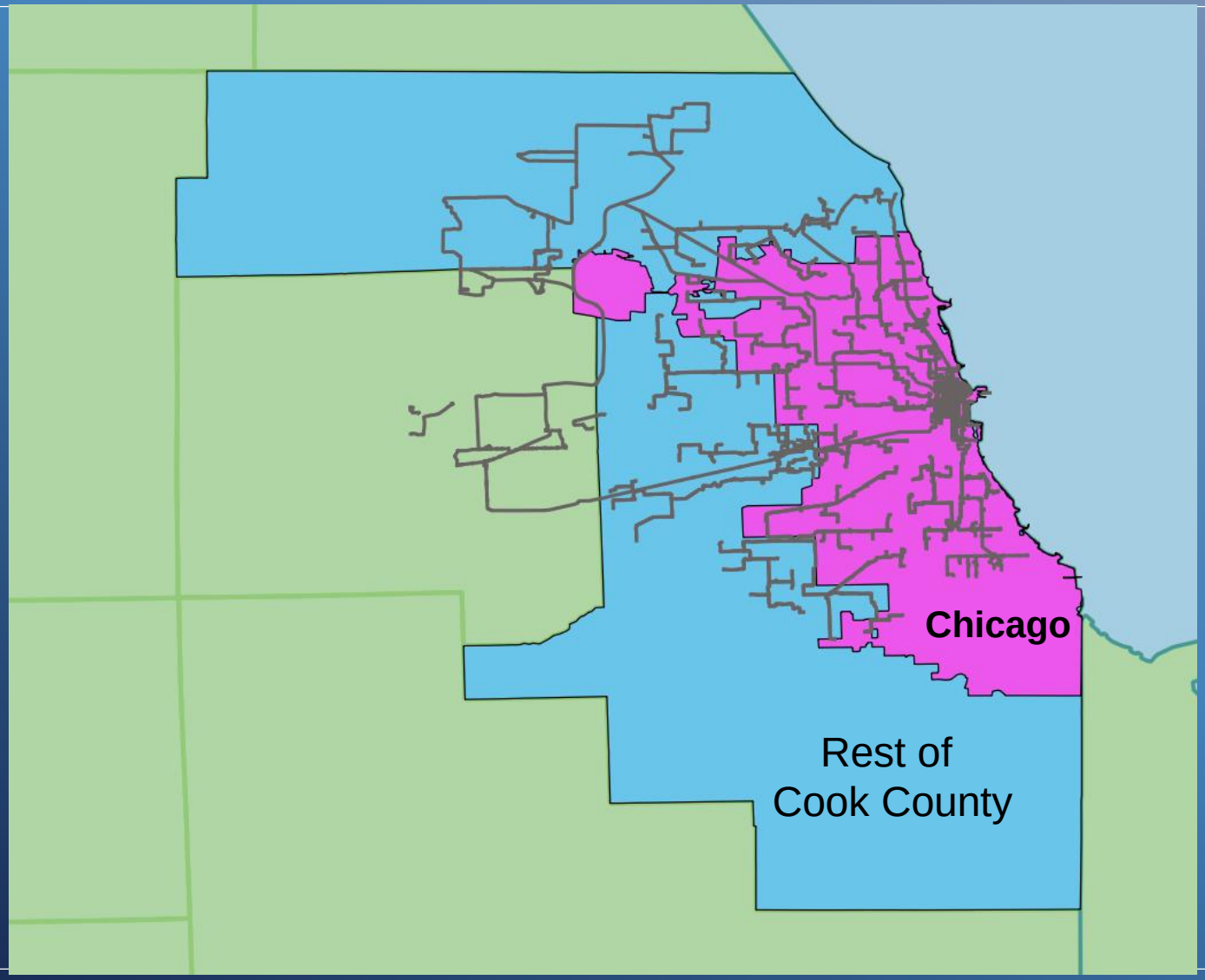
Thank You

BACKUP

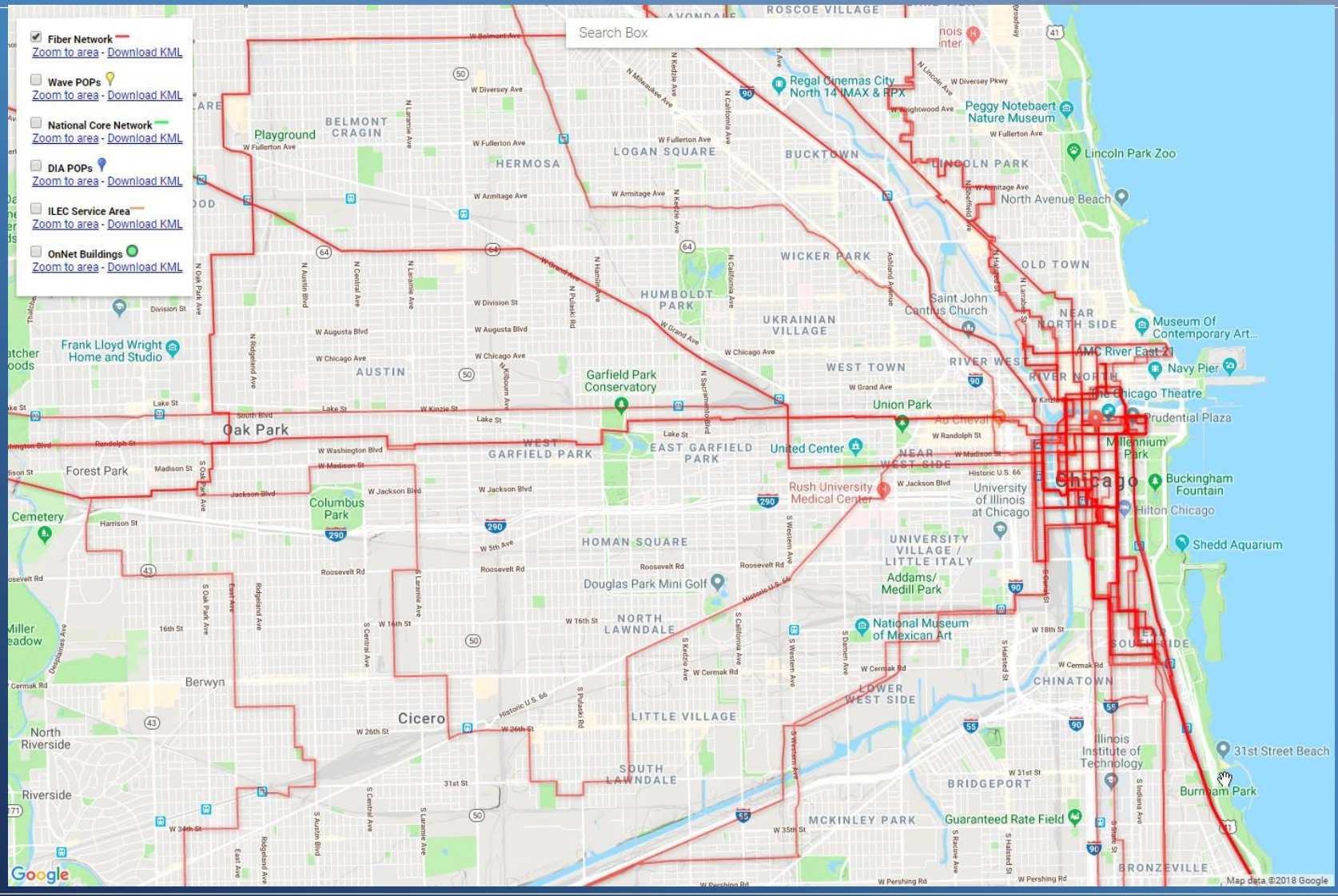
Provider 1: Crown Castle Fiber Network



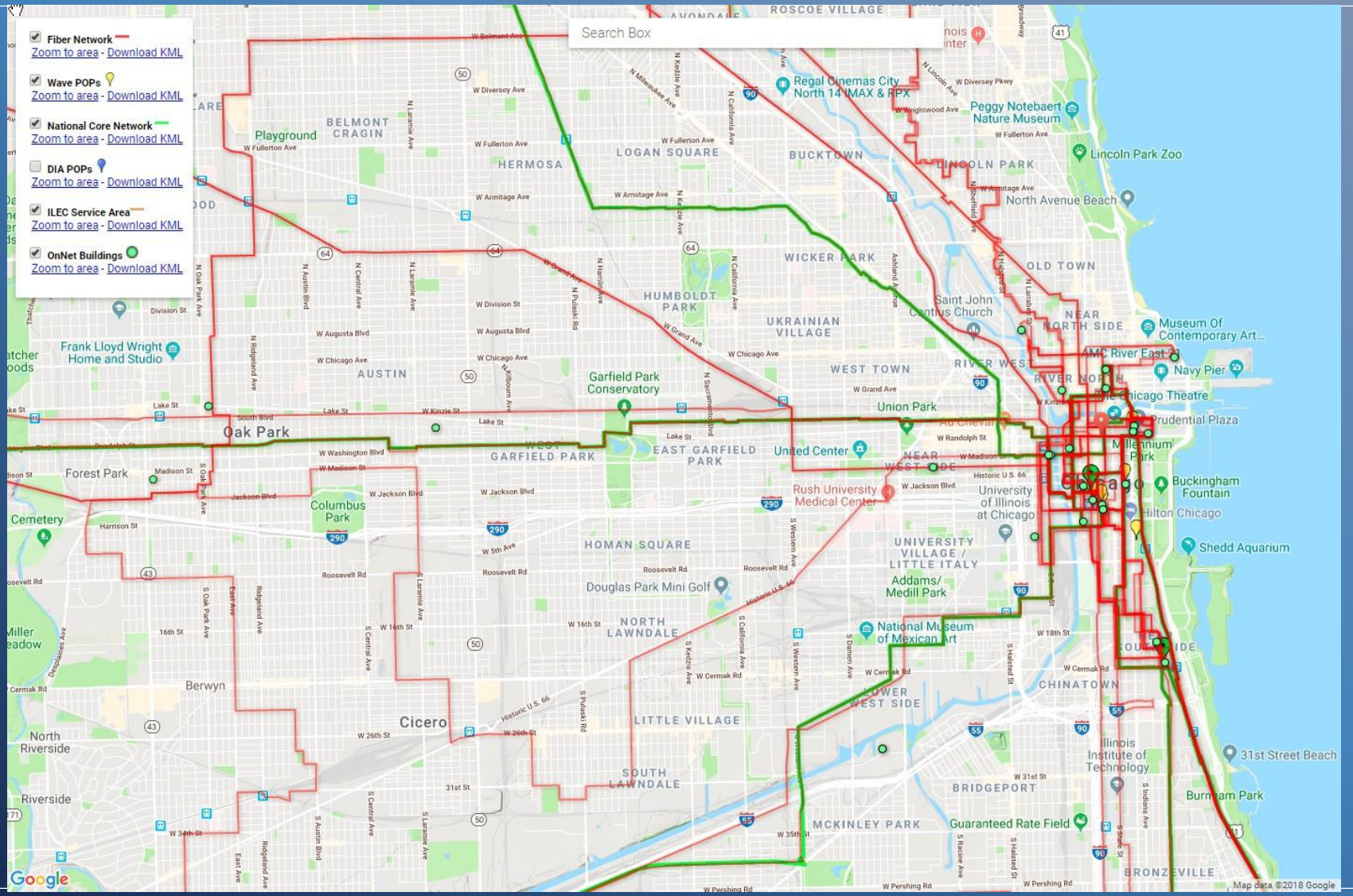
Provider 1: Crown Castle Fiber Network (contd.)



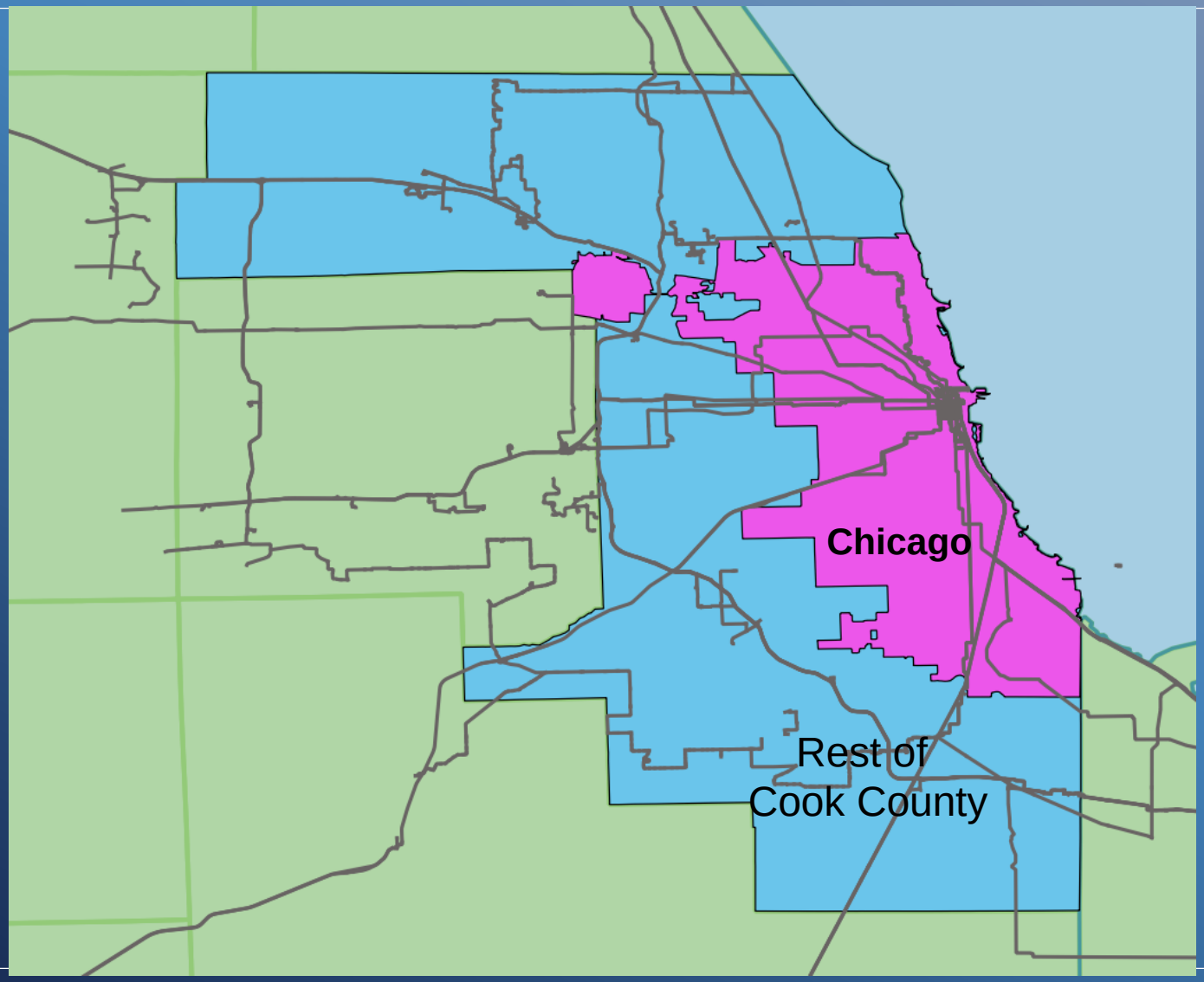
Provider 2: Windstream Fiber Network



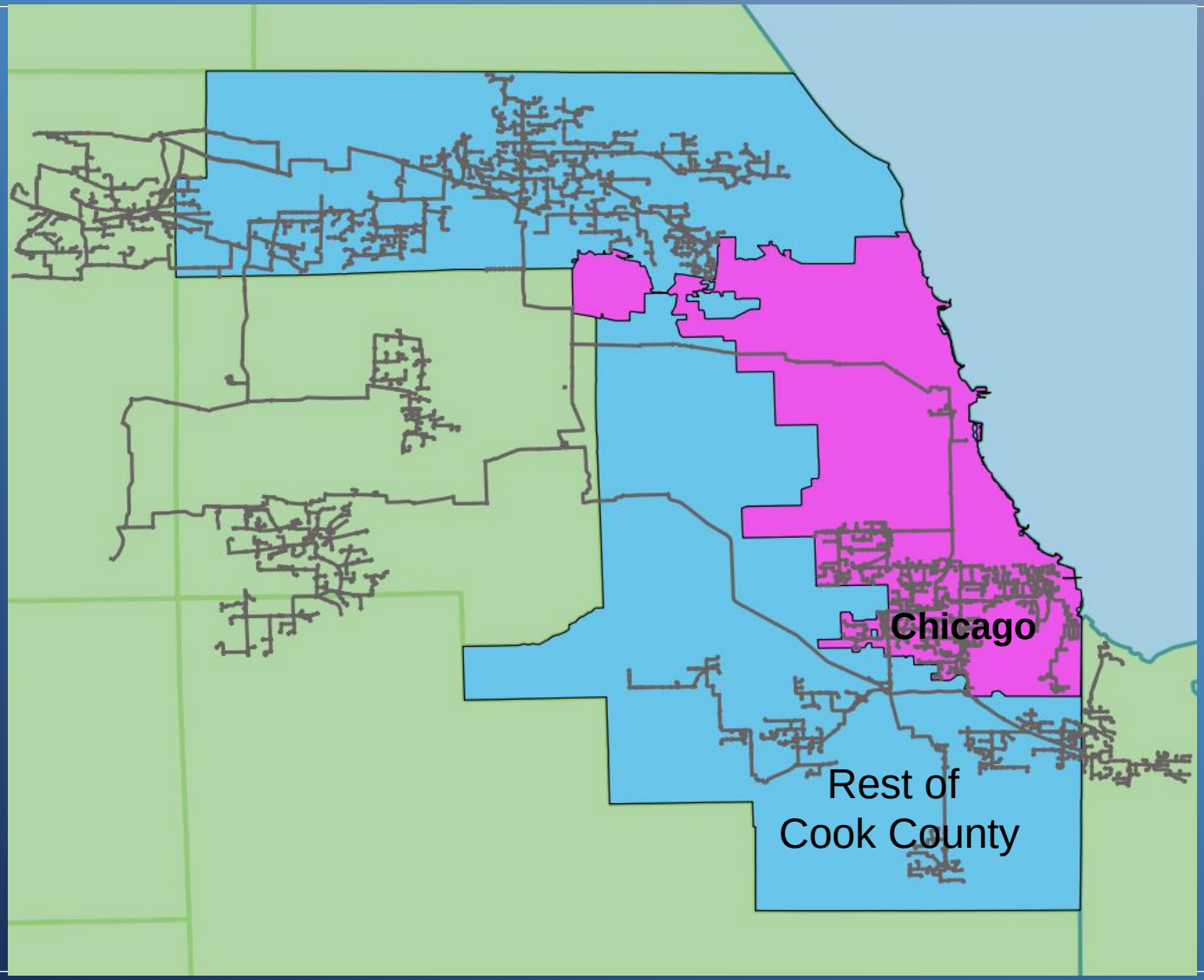
Provider 2: Windstream Fiber Network (additional detail)



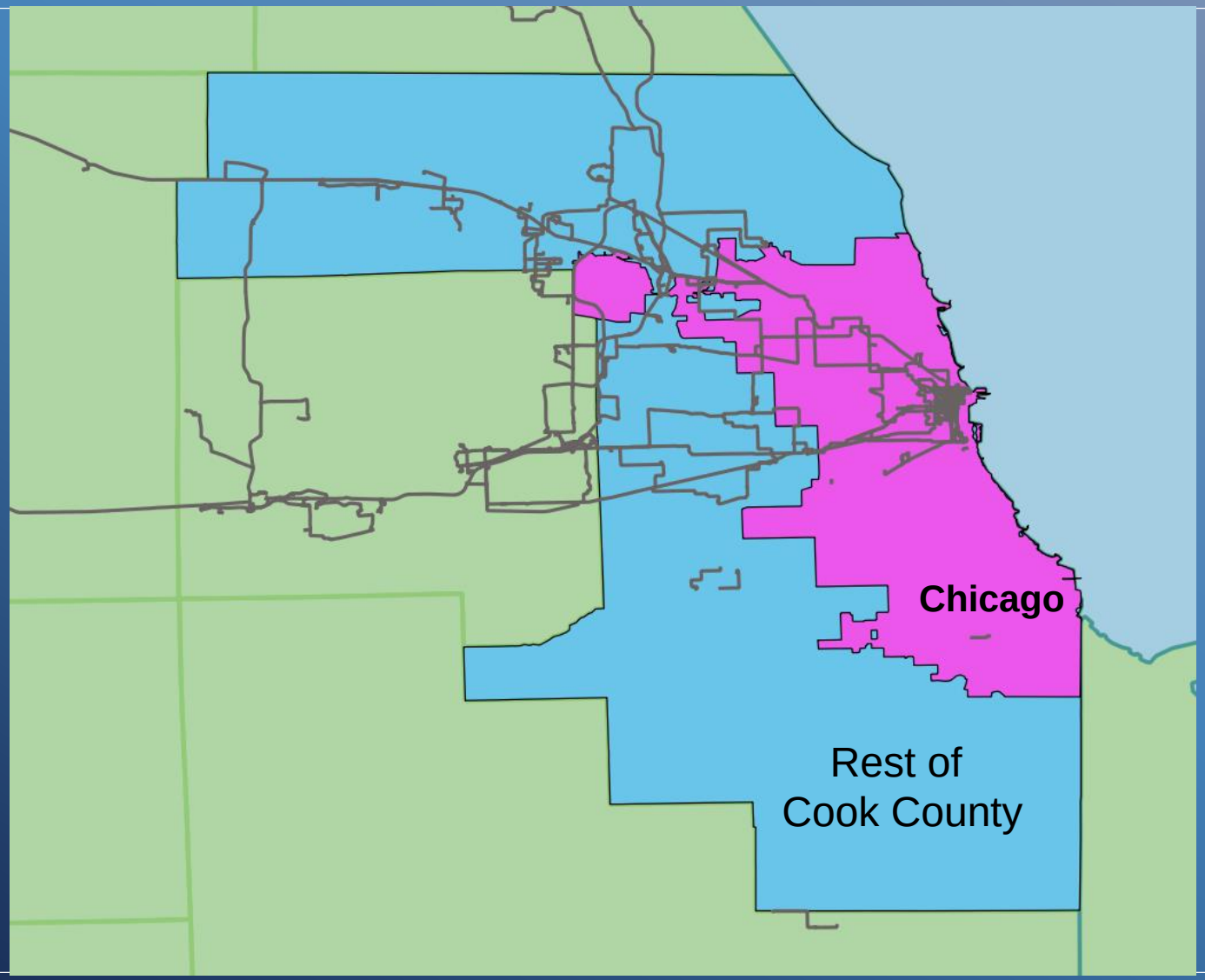
Provider 2: Windstream Fiber Network



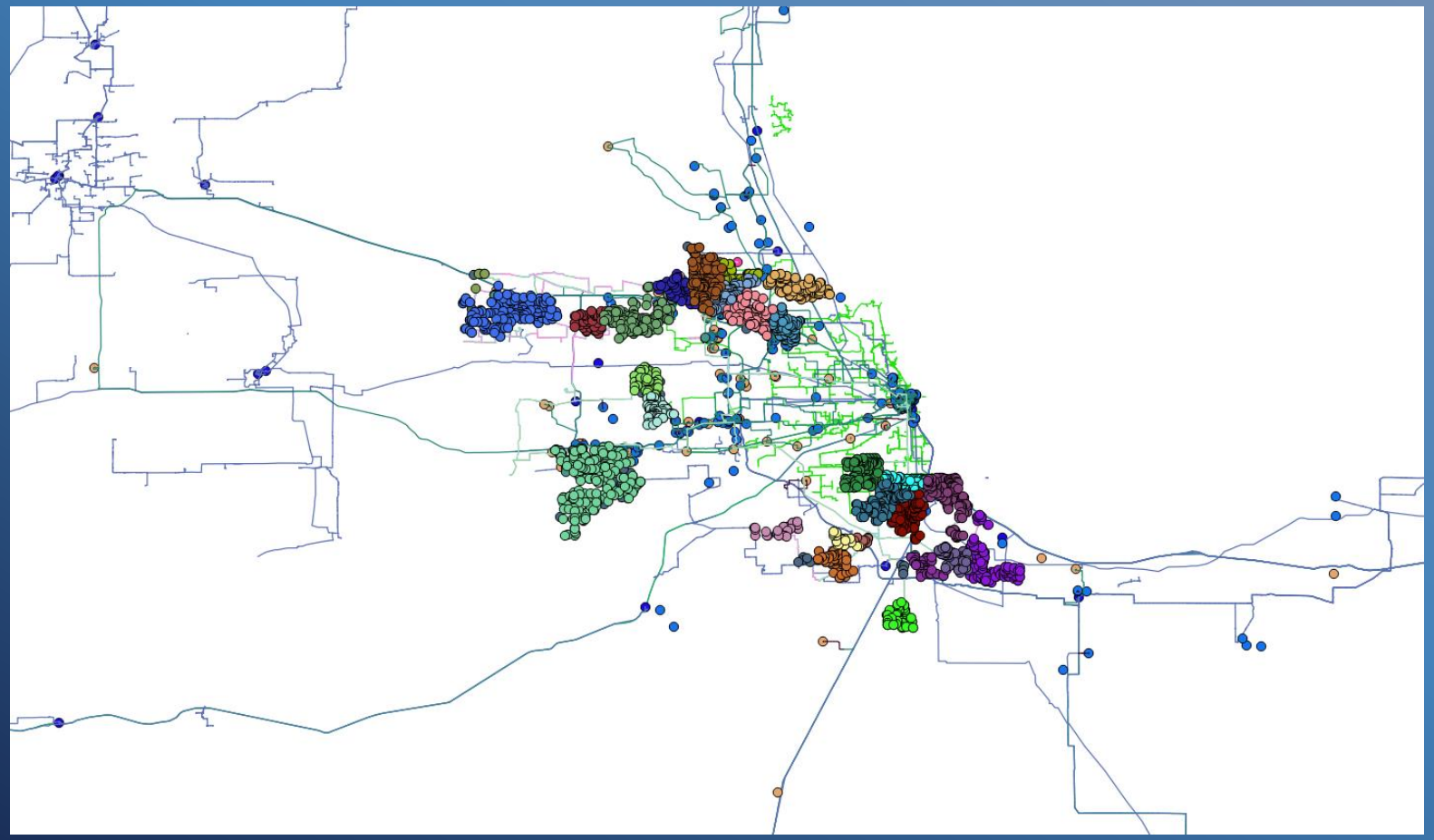
Provider 3: Wide Open West (WOW) Fiber Network



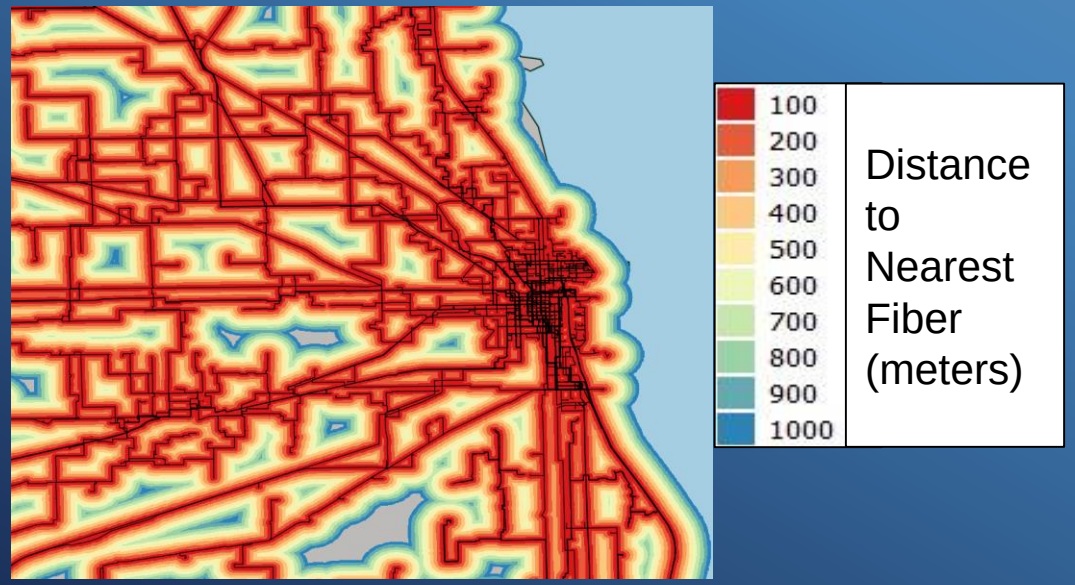
Provider 4: Zayo Fiber Network

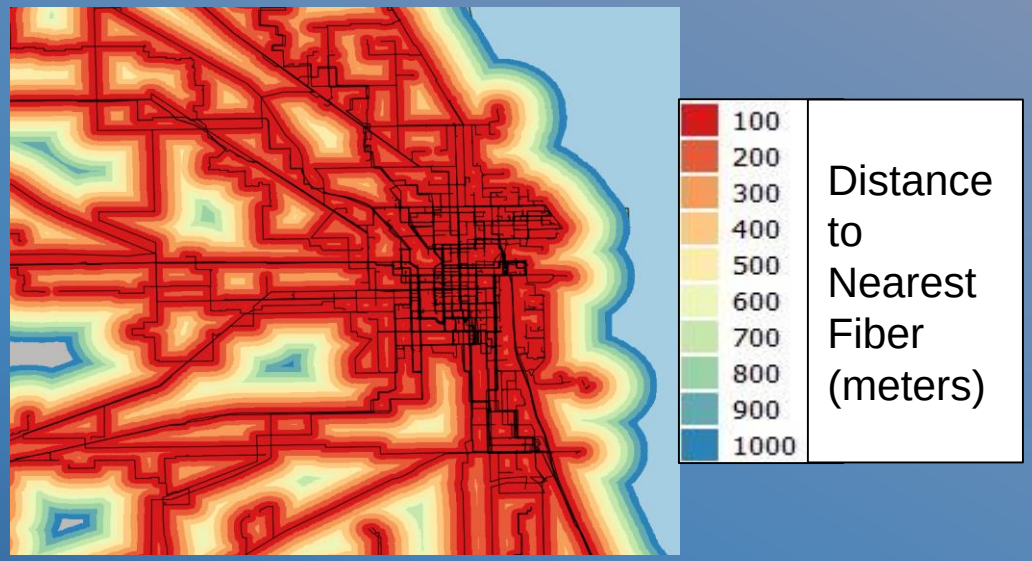


Chicagoland lines and nodes



Chicago (Urban Core) Proximity Heat Map





Enlarged views of Proximity Heat Map (Core of Urban Chicago)